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Erie and Los Angeles

THOSE who have followed flood-prevention matters closely will be very much interested in two articles in this issue, the one being an account of the Erie flood and the other an abstract of the flood-prevention report recently rendered by Los Angeles' engineers. The Erie situation is discussed in another editorial in these pages and needs no further attention here. The Los Angeles report is chiefly of interest in that it proposes two schemes novel so far as American practice or recommendations go. One is the spreading of the flood waters in the upper reaches, so as to store them in the gravel and retard their flow into channels of destruction, and the other the impeding of the flow in steep canyons by the construction of impeding dams. On neither head is sufficient information available at present to speak with an air of finality. The proposals are, at present at least, chiefly of interest. Nevertheless such observations as have been made in a number of canyons near Los Angeles where impeding dams have been built indicate that they may have a very valuable influence in desynchronizing the peaks from the various tributaries to a main and important channel. Not only do the dams impede the flow but they give an opportunity for the growth of brush, which affords an added retardant. It is interesting to know that an experiment station, equipped with a suitable dam and gaging stations, has been provided near Los Angeles in order to study thoroughly the effect of these dams. It is to be hoped that the appropriation suggested in the report will be made, to the end that complete data on this interesting scheme may be made available. The Erie flood, coming hard upon those at Dayton and Los Angeles, with many minor disasters in various parts of the country, shows the wisdom of the comprehensive studies made in a few locations. Other communities must awake to their danger, and flood prevention investigations must become fairly common in the near future. Unless they do, serious disaster will continue to be invited.

The Porjus Plant

THE TECHNICAL side of the Porjus development (see page 194) has features to which special attention should be called. American engineers will probably differ with their Swedish brethren in the selection of double-runner units. Here the single-runner, high-speed, high-power wheel has been made the standard, and at Porjus would probably have given higher efficiency than the design actually adopted. At Ni-

agara Falls double-runner units are used in most of the plants, but the advances in the design of single-runner wheels have led the Canadian Niagara Power Company to design its new units with single runners. Three wheels of this type are proposed and will run at the same speed and have the same output as the double-runner units in the same plant. Single-runner units, too, would have been of material advantage in the design of the generator room, as the floor could have been located at a higher elevation, thus doing away with the costly waterproofing and drainage system. The method of connecting the vertical penstocks with the forebay could also, it would seem, be improved upon. As now arranged, the penstocks do not connect directly with the forebay, a gate being interposed between them. While the engineers have figured this forebay to act as an ordinary surge tank, the interposition of the gate will really give a differential action. A design of this sort was used at a Canadian plant some years ago, but the trouble encountered was so serious that both penstocks and units had to be replaced. The surge chambers on the tailrace tunnel are, of course, unusual, but only because the type of plant with a long discharge tunnel is more or less uncommon. Similar chambers, it will be remembered, have been used at the large Mockfjard plant, completed in Sweden somewhat over two years ago.

Discussion at the Congress

THE papers to be presented at the International Engineering Congress in San Francisco next month will be, in at least one important particular, radically different from those ordinarily read before technical societies, and therefore a word about the kind of discussion that will be in order may not be amiss at this time. The special feature of these papers is that they have been drafted primarily to present a concise review of the best contemporaneous methods and practices in the branches of engineering covered. If papers prepared with this primary object are discussed by a gathering of experts and the good points of the discussion are properly edited, it will be possible to compile in the bound volumes a symposium on engineering which will be unique in the history of technical literature. However, to make this possible, and the Engineering Record assumes that all who attend the congress will concur in desiring this end, it is desirable that the discussion shall include comment from a large number of engineers, each viewing the subject from his own angle and each in a position to speak from experience. This will only be possible, in view of the brief time allotted

for each session, if all bear in mind that comment must be limited to that which is strictly to the point. In the numerous sessions of the congress there will be opportunity for discussion on a wide range of subjects, there will be a proper time and place for all important comment and there will be no excuse for introducing other than strictly relevant discussion in any session. The system adopted for reporting the proceedings of the congress prevents even a temporary record of irrelevant discussion. The several committees which have been appointed to organize and direct the compilation and presentation of the papers have been working in a most commendable manner toward making the congress productive of the very best results. Excellent papers have been secured. It remains only to secure a large volume of pertinent discussion to insure the unqualified success of the meeting.

Swedish Power Development

COMPLETION of the Porjus hydroelectric plant, described in this and in the preceding issue of the Engineering Record, marks the end of the first important step in the hydroelectric development program adopted by the Swedish Government in 1906. Economically it is of singular importance in Swedish affairs. As is quite generally known, the country is rich in potential power projects, yet when coal prices are normal about \$5,000,000 is paid out by Swedish railways annually for imported coal. Added to that is a tremendous consumption of foreign fuel in the industries. It was, after a careful survey of this situation, that the Government itself determined to enter into the ownership of hydroelectric plants, primarily for the purpose of electrifying the State railways. Power rights were purchased at the very start on three streams, but not until 1910 was the Porjus project outlined and authorized. The selection of this as the first development was due to the excellence of the prospective power load, that is, the transportation of ore in large volume and over heavy grades. The power available at Porjus, however, was more than sufficient for the electrified line from Kiruna, in the mine fields, to the Norwegian frontier, but investigation showed that the mining industry of the district would furnish an ample market, even at the start, for a considerable surplus power. Furthermore, it seemed likely that the market would grow and justify the extension of the plant when water was made available by the construction of storage works on the Lule lake and river system. Aside from the hard and cold economic facts, however, the Govern-

ment felt, on comparing the Porjus plan with an alternative project that it would be decidedly advantageous to encourage development in such a remote section of the country, and while this was a minor consideration, it nevertheless had weight with the Swedish Legislature in voting for the Porjus as against the other proposal.

Should the Rattler Go?

IN VIEW of the doubt frequently expressed as to the value of the rattler test it is not surprising to learn that one city—St. Louis—has after a long use of this type of testing equipment abandoned it in favor of ordinary visual inspection. Just what will be the outcome of the St. Louis experiment cannot at present be foretold, but judging by the knowledge accumulated by the St. Louis Municipal Testing Laboratory for a number of years as to the output of each of the plants likely to sell in St. Louis territory the result should be satisfactory. As a matter of fact, acceptance of paving block does rest primarily upon the visual test, the fact being long since determined that certain plants regularly meet the specifications so far as the rattler is concerned. That does not mean that the rattler test has not been made, but merely that the block has so consistently passed that the actual acceptance or rejection has depended upon visual inspection. There can be no question but what the rattler performs one very excellent function—as a definite and final arbiter between engineer and manufacturer. It must not be supposed, however, that the St. Louis engineers would advocate dispensing with the rattler when the product of a new plant was first to be considered. They hold, rather, that it may be safely dispensed with when the product of the plant is already pretty well known. In other words, the visual inspection is relied upon to test the variations from a given plant, the absolute comparison, however, of a block from one plant with that from another not being involved in visual inspection. No one contends that the rattler test is rational, that is, that its results are at all comparable with the service which block is expected to render in service. Resistance to abrasion and strength to withstand blows are, of course, necessary in the pavement and are revealed to some extent by the performance in the rattler, but thoroughly rational the test is not. With competent and reasonable inspectors the St. Louis scheme should work very satisfactorily. With arbitrary inspectors, and no recourse to a test independent of the personal equation and judgment, such a specification may work a hardship on a manufacturer.

Aero Engineering

NEW branches of engineering that appear from time to time and are novelties for awhile, almost without exception develop into important fields in which specialists are trained and which finally become closely identified with the necessities

of civilization. Such will undoubtedly be the case with aero engineering. It is interesting to note the variety of influences which are working to develop the art of flying to a point where it will be more useful than at present. The greatest of these, of course, is the need for air craft in military operations, and no doubt much progress toward the production of safer and more effective machines will result from the urgent need in the present European conflict. However, so great is the need for military air craft that other fields of usefulness are likely to be lost sight of, and it may be worth while to point out some of these. Recently, on the occasion of an accident to a pleasure boat just off shore from a popular beach resort in California, it was demonstrated that an aeroplane could be used effectively for dropping life preservers to persons struggling in the water beyond the surf line. This incident started a campaign to have the life-saving service equipped with aeroplanes. The plan, if successful, would greatly increase the effectiveness of that department in carrying aid to vessels in distress. Post-office officials in Washington have long recognized the advantage of using aero delivery service for crossing the deserts and mountains of the West and North, and in many cases where means of communication are uncertain it seems almost a necessity. Even in well settled Western districts mountain chains often necessitate circuitous rail routes, and these afford opportunity for great time-saving if aerial mail service were established. For example, a letter leaving Portland, Ore., on Monday does not reach Eureka, Cal., via San Francisco, until Thursday, yet the stretch which causes the delay could be bridged by a two-hour aerial run between Eureka and Redding, Cal., which are only 95 miles apart as the crow flies. Those whose duty it is to watch for forest fires, to patrol transmission lines or to carry relief into frozen wastes or the desert areas, and, in short, many whose work is now accomplished under difficulties because of transportation problems, will be able greatly to increase their range and efficiency when the aeroplane as a safe and well controlled conveyance is at their disposal.

Drowning Sensational Reports with Truth

NEED for education of the public in engineering matters has been commented on in this journal many times, but a trivial accident in Chicago last week brought it to the front vividly. Tension over the safety of the public on all kinds of transportation facilities is at an abnormal pitch due to the Eastland disaster. It was reflected in the hysteria with which some of the newspapers magnified an insignificant collision of two elevated trains on the Wells Street bridge, overlooking the overturned boat. Questions as to whether an elevated train could plunge into the river through an "open" bridge were anxiously asked. None of the reporters thought to go to the offices of the company

to find out what safeguards, if any, were provided to prevent such an accident.

Finally the engineers of the company called up one of the dailies. They found the editor more than willing to be shown. Finding the reporter he sent was interested, the electrical engineer and engineer of maintenance of way spent three hours with him, first going over the plans of the interlocking system and then demonstrating to him on the ground the various safety devices. A boat came through and he saw the sequence of six distinct safeguarding operations which finally permitted the bridge to be opened. The engineers concluded just for once as an experiment to take plenty of time to get the idea into the reporter's head correctly. Whether they were disappointed or not, the newspaperman's article, logically handled, could not help but allay any fears that the earlier discussions had aroused in the minds of thousands of thoughtful readers.

It will pay the engineering profession big dividends to be patient with the newspaper man, to give him plenty of attention and time so that he can thoroughly understand an intricate problem. He cannot put his ideas on paper in an intelligent way unless he has grasped the situation. Once understood he can be trusted to feature the big points in their proper proportions. The lesson to engineers is, as Professor Newell has explained it, to drown out the sensational, which is rarely correct, with plenty of truth.

Plumbing as Viewed from the Engineers' Standpoint

WITHIN a generation a great change has taken place in the status of plumbing. Thirty years ago sewer-gas was regarded as an important cause of certain diseases, and even ground air was so much feared that Prof. William Ripley Nichols, chemist of the Massachusetts State Board of Health made a study of the ground air of the Back Bay district of Boston to ascertain if it possessed harmful characteristics. Suffice it to say that the celebrated chemist gave the ground air a clean bill of health, while present-day bacteriologists absolve sewer air from the charge of disease transmission.

To a great extent, therefore, plumbing has ceased to be an acute health problem. That being the case why should not the inspection of plumbing be transferred from health to building departments? There already appears to be a drift in this direction. Also, if the question of health be a remote one, why should not there be a material simplification of plumbing designs with an elimination of some of the useless vent pipes, running traps, and what not? The money thus saved might well be expended in better materials and more fixtures.

In another respect the plumbing business has changed. The day of the lead worker has passed. The plumber is no longer a skilled handler of lead; he is becoming an assembler of fixtures, machine made and easily put together. The number of wiped joints is being steadily decreased and the

skill demanded of the workers is being lessened day by day. It is, of course, desirable and necessary to have pipes and fixtures well installed, because even though sewer air may not cause disease it should not be allowed to contaminate indoor air. It is offensive and, after all, may be found to be not wholly without influence on health. Plumbers should, therefore, be licensed as heretofore and care taken to have good workmanship. But greater emphasis should be given to the inspection of plumbing materials. Standards should be set, not only for pipes but for all sorts of fittings and for connections.

Another matter that deserves study is that of fitness of materials for particular services, as, for instance, the relative value of cast-iron or wrought-iron for soil pipes and the use of brass pipe for hot-water services. There are scores of problems of this character that might be profitably studied. With the cost of plumbing installations equaling 5 to 10 per cent of the total cost of buildings, and with our large office and factory buildings housing as many people as are found in a small village, it is time that great attention be given to plumbing not so much from the standpoint of health as from that of economy and efficiency. Furthermore, the steel frames of our buildings may be liable to injury from the escape of moisture and corrosive gases through holes in pipes. Such being the case, plumbing standards cannot well be neglected.

City and Corporation Co-operate in Subsurface Problems

AN INTERESTING case of possible co-operation between a municipality and a public-service corporation has been brought to light by the study of the subsurface conditions in New York made by the Public Service Commission. It appears that the present gas companies in New York represent the end results of the consolidation of six companies, all of which had one or more mains in various streets. As a result, there are probably about 500 miles of unnecessary line. As franchises of some of the companies have expired, the city has insisted, previous to the laying of new pavements, that the old lines be cut out of service. However, when subsurface structures interfere with proposed subway lines the Public Service Commission, under the law, is obliged to restore the property as far as possible as it finds it, or in any event to provide an equivalent service. That would mean that even if one main were adequate to the service and two others were in the street, having been laid by one of the merged companies and now unnecessary, the commission nevertheless would be obliged to furnish capacity equivalent to the three in the restoration. Apparently this is a great waste for the city and of no value to the gas company. In fact, it may be the source of loss to the latter because of the higher maintenance charges. Nevertheless, the company cannot stand idly by and allow the mains which still hold fran-

chise rights to be eliminated. The value of these mains has been capitalized and to destroy them would require changes in the capital account. For that reason the situation is not one to be decided by fiat, but is distinctly of the type of problem where broad-minded consideration is necessary on part of both the city and of the company. In the long run, no doubt, both would be gainers by the elimination of unnecessary lines.

In reporting on the subject recently, Charles N. Green, engineer of subsurface structures of the Public Service Commission, suggested that this matter be taken up with the gas companies with a view to adjustment. He recommended also that legislation be secured which would allow the three companies now existing (two of which are controlled by the largest company, the Consolidated) to consolidate, thus releasing a still greater number of lines, and that unnecessary franchises be condemned. Further than this, Mr. Green recommends that a new system of gas distribution be designed, that all changes be made to conform to it and that the advisability of locating certain structures under the sidewalk be considered. The last point, the use of the sub-sidewalk space, has already made marked progress in New York. There is no question as to the desirability of water, electric-light and pneumatic-tube services being so placed, but there is question as to whether this is a suitable location for gas mains, due to the danger of leakage and resulting explosion. Nevertheless by a proper design it may be possible to overcome the objections that have been offered.

Taken altogether the problem is one that can be solved only by co-operation between city and company. The present procedure is not only wasteful, and therefore should not continue, but results in taking space unnecessarily that may before long be needed for other utilities.

Preparedness—What Its Neglect Cost Erie

PREPAREDNESS is a word which has been so closely linked with the subject of national defense that, for the present at least, people are apt to think of it only in terms of battleships, coast defenses, munitions and military training. The recent flood at Erie, Pa., which collected a toll of thirty lives and several million dollars in property damage, is a forceful reminder of the need for a kind of preparedness which has nothing to do with war.

Theodore E. Seelye, who visited the stricken Pennsylvania city in order to give to the readers of this journal the facts regarding the flood, does not mince words in stating just what was responsible for the disaster. In his article on page 186 he lays the blame squarely upon the inadequate waterway of Mill Creek, due to encroachments by buildings and insufficient bridge and culvert openings. When, on Aug. 3, rain fell at an excessively high rate—4.31 in. in 4 hr.—the restricted stream channel,

which passes through the very heart of the city, was called upon to perform the task of carrying a flow far beyond its capacity. The invasions of its right-of-way by structures misplaced or poorly designed could have but one result—the backing up of the flow and the accumulation of debris which, forming impromptu dams, served to divert the surging current into the city streets. Buildings were floated from their foundations or were undermined and collapsed, pavements were ripped up, water and gas mains broken and all the damage characteristic of other severe floods was done.

Who, then, is responsible for allowing the channel of Mill Creek to become cluttered with obstructions which strangled its free flow at the very time when it should have been working at maximum capacity? The city had ample warning of the damage which would follow an intense precipitation, for the flood of Aug. 3 was the third of its kind, the other two having occurred in 1893 and 1878. It is fair to assume that the city's engineers must have foreseen the possibilities of an unusually severe storm but, assuming that they did so, it is not unthinkable that their recommendation should pass unheeded by the authorities empowered to approve of the location of encroaching or inadequate structures or to supply funds for the improvement of the creek. In this connection a quotation from Mr. Seelye's article is illuminating:

"The failure of the 50-ft. dam at Austin, Pa., on Sept. 30, 1911, resulted in the passage of a law by the Legislature of the State, providing for the investigation of the safety of every dam, and that no new dams could be built until the plans had been approved by the State Water Supply Commission. This law also provided for the approval of plans for bridges, culverts and encroaching buildings or other structures. Unfortunately the buildings and encroachments which caused the damage along Mill Creek were built before this law was enacted. Recently applications have come before the commission for the construction of culverts and buildings on and along this stream, and the engineers of the State have pointed out the necessity for leaving a large unobstructed channel and have met with decided opposition."

It generally takes a disaster such as the one at Erie to overcome opposition of the kind to which Mr. Seelye refers. The catastrophe emphasizes again the need for the supervision, by a disinterested body, of the occupancy of flood-plain land and the adequacy of bridge openings. Upon city and State officials there rests a responsibility for preparedness against repetitions of the Erie flood which, taken in the aggregate, is by no means insignificant when compared to preparedness of a strictly military nature. And yet, just preceding the Erie flood, the State of Pennsylvania felt obliged to adopt measures of retrenchment which resulted in the curtailment of the activities of the State Water Supply Commission and the discharge of a number of the members of its engineering staff—the very men specially qualified to forestall such disasters as the one of Aug. 3.



ERIE'S STREETS AFTER THE FLOOD WERE PILED HIGH WITH THE WRECKAGE OF FALLEN BUILDINGS

Restricted Stream Channel Responsible for Erie Flood Damage

Encroachments by Buildings, Bridges and Culverts on Line of Mill Creek Back Up Water of Severe Storm, Causing Loss of Thirty Lives and \$2,000,000 Property Damage

By THEODORE E. SEELYE

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THE loss of thirty lives and \$2,000,000 worth of property by floods following the severe storm at Erie, Pa., on Aug. 3, was due to encroachments by buildings, bridges and culverts upon the channel of Mill Creek, which passes through the city for 3 miles. The rainfall of 4.31 in. which preceded the catastrophe resulted in a runoff too great for the restricted channel to carry off, and the water backed up at points narrowed by encroaching buildings, inadequate bridges and culverts until these structures failed and the accumulated water and debris descended to repeat the operation at a lower point.

MILL CREEK AND ITS WATERSHED

Mill Creek flows into Presque Isle Bay, Lake Erie, through the city of Erie, draining at its mouth 12.9 sq. miles. It rises a few miles to the southeast of the city and flows west, parallel to the lake shore and 3 miles south of it, turning abruptly north about 2 miles before it enters the built-up section of the town. Its watershed lies in the sandy, gravelly soil typical of this once glaciated region, and is underlaid at a slight depth by a gray slate formation which is productive of a high rate of runoff. It is in a high state of agricultural productivity, containing, however, no other municipalities than Erie. The countryside is composed of rolling hills with little timber on them or in the valleys. Just before entering the city the stream emerges from a narrow valley through which it passes for about 2 miles. The sides of this valley rise steeply about 100 ft. above the water.

Its slope through the 2.75 miles of its course within the city is very steep, the fall being 187 ft., or nearly 70 ft. per mile. Beyond the city limits the fall is 47 ft. per mile, and becomes less steep farther upstream. This character of profile is most unusual, and is due to the descent from the higher lake terrace, on which most of the watershed lies, to the Lake Erie level.

The thriving city of Erie lies upon the shores of Presque Isle Bay and has a population of about 75,000. It is the center of a large manufacturing district and is provided with transportation facilities by the New York Central, Pennsylvania and Nickel Plate railroads and by navigation upon the lakes.

The recent flood on Mill Creek was the first serious catastrophe suffered by the city, though two previous floods had resulted in some damage. Considerable difficulty was experienced in the search for bodies, due to the immense piles of wreckage and debris, and it will probably be some time before an accurate death list can be made. It is believed that a majority of the deaths were caused by crushing and blows from debris. From authentic sources it was learned that several people were removed from the wreckage, still alive, as long as 48 hr. after the flood.

The flood took its course through a low-lying portion of the city, and most of the houses destroyed were of the cheaper type, although in the lower reaches an excellent residential section lay in its path. Altogether about 200 houses were destroyed, including residences, public garages, jobbing houses and manufacturing plants. An area about 2½ miles long and one to three blocks in width was affected. State Street, the main business street, suffered only to a slight extent, although in close proximity to the raging waters, which in a few places flowed to a depth of several feet over its surface.

The fact that the damage was wrought

after dark, between 8.30 and 9.30 p. m., made the loss of life greater among the residents of the district, although it probably resulted in less loss of life in the mills and business houses. Owing to the darkness rescue work was most difficult, and lives were lost which might otherwise have been saved. There was, however, great heroism shown in many of the rescues. Many people who had gone to bed were taken unawares, and had no opportunity for escape when their houses were floated off by the current.

FLOOD WARNINGS UNHEEDED

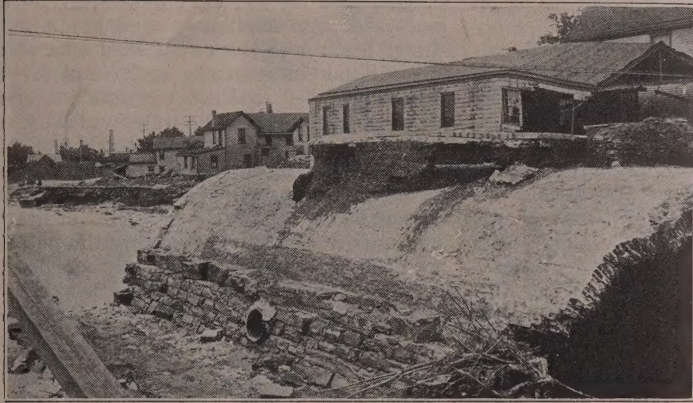
There is one striking point which stands out among others with regard to the human element in this flood. The fact that so long a time had elapsed, over twenty-five years, since this stream was in flood before, made it impossible for many of the people, even though they were warned, to believe that this tiny stream with which they were familiar could possibly reach the heights and do the damage which it actually did. These people, therefore, did not heed the warnings which were given them and remained in their houses to be carried off with these structures when they went downstream.

Immediately upon the receipt of word of

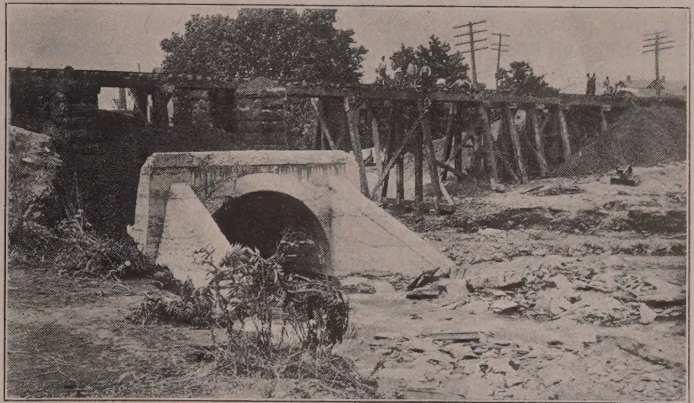


ALONG PARADE STREET FRAME HOUSES WERE SWEEPED FROM THEIR FOUNDATIONS

The Path of the Erie Flood Is Marked by Battered Structures, Eroded Streets and Piles of Débris



ALL THAT IS LEFT OF A BRICK ARCH BRIDGE



REPAIRS STARTED ON NICKEL PLATE RAILROAD CULVERT



SEVENTEENTH STREET BRIDGE WAS COMPLETELY WRECKED



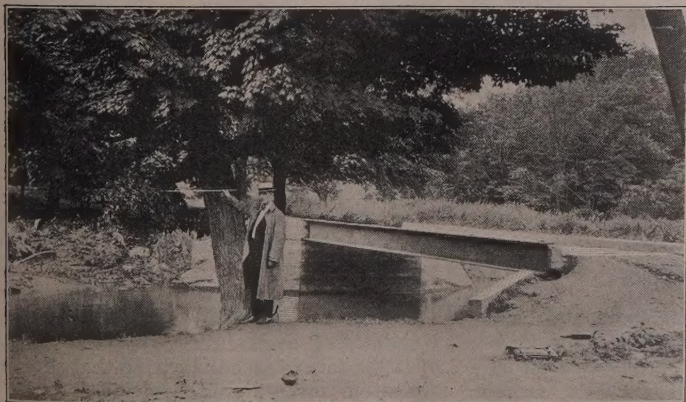
SIXTEENTH STREET BRIDGE CHOKED BY FLOOD DÉBRIS



ASPHALT PAVED STREETS WERE RIPPED UP BY CURRENT



GARAGE WHICH WAS UNDERMINED AND COLLAPSED



HIGH WATER REACHED LEVEL 12 FEET ABOVE CREEK BED



GLENWOOD CONCRETE DAM WHICH WITHSTOOD FLOOD

the flood the State Health Department sent men to Erie to look after the health and welfare of the city and to direct the clearing up of the debris. The State constabulary, Federal marines, State militia and the city police guarded the damaged district against pillage. The Health Department men were all experienced in the very similar conditions which they found at Austin after the failure of the dam above that town four years ago. The Water Supply Commission of Pennsylvania was also represented by some of its engineers.

RECORDS OF RAINFALL

The water performed many freaks in its passage through the city. Sheets of asphalt, 20 ft. or more square, were torn up, and in some cases were left standing on end against buildings. Large frame buildings, sometimes practically intact, were moved to new sites, or wedged in between other buildings. Steel superstructures of bridges, smoke-stacks, boilers, automobiles, and other heavy objects were carried long distances.

The rainfall from noon, Aug. 3, to noon, Aug. 4, was the greatest recorded at the

Three distinct storms are to be noted in the precipitation record, one occurring between 4 and 4.30 p. m.; one between 5.15 and 5.45 p. m., and the last between 6.30 and 7 p. m.

The earlier storms were of sufficient intensity to saturate the top soil thoroughly and fill the stream, while in the periods between storms, about 45 min., a sufficient amount of rain fell to maintain a complete saturation and cause a high rate of runoff for the last part of the rain.

The maximum rate of discharge during the flood is difficult of determination, but all the methods used indicate that it was unusually high and some unexpected results were obtained. Three methods were used—the discharge over the Glenwood Dam, Kutter's formula at a section of the creek about 1500 ft. below the dam, and by a distribu-

section indicated a slope of 1 per cent. With $n = 0.066$, a discharge of 8855 sec.-ft. was obtained, or at the rate of 850 sec.-ft. per square mile for the 10.4 sq. miles of tributary drainage area.

The third method used was to divide the watershed into small areas, and, assuming a distribution over the entire shed of a rainfall similar in intensity and character to that which fell in Erie, compute the time interval required for the water vented from each section to reach a given point. This method is applicable only to small watersheds. By this method a runoff of approximately 900 sec.-ft. per square mile of drainage area was obtained. The maximum rate of discharge was probably at the rate of about 800 sec.-ft. per square mile.

The bridges over the stream at the street crossings were largely responsible for the

AT RIGHT — REMAINS OF TWO BRIDGES WHICH CROSSED MILL CREEK



AT LEFT—FLOOD WASHED OUT ABUTMENTS OF STATE STREET BRIDGE



U. S. Weather Observatory in Erie during the forty-two years since its establishment, a total of 5.77 in. having fallen from 3.24 p. m., Aug. 3, to 5.30 a. m., Aug. 4. The larger part of the precipitation occurred during the first 4 hr., when 4.31 in. were recorded. The greatest intensity for 5 min., 10 min., etc., is shown in Table 1:

TABLE 1.—GREATEST RAINFALL INTENSITY FOR DIFFERENT TIME INTERVALS

Period	Inches of Rain
5 min.—6.44 to 6.49 p. m.	0.39
10 min.—6.43 to 6.53 p. m.	0.66
15 min.—6.34 to 6.49 p. m.	0.87
30 min.—6.24 to 6.54 p. m.	1.38
1 hr.—5.53 to 6.53 p. m.	1.50
2 hr.—4.53 to 6.53 p. m.	2.84
3 hr.—3.53 to 6.53 p. m.	4.04
4 hr.—3.24 to 7.24 p. m.	4.31

It will be noted that the greatest intensity was recorded for the 10-min. interval between 6.43 and 6.53 p. m., when 0.66 in. fell.

The precipitation by 15-min. intervals from 3.30 to 7.30 p. m. is given in Table 2:

TABLE 2.—PRECIPITATION BY 15-MINUTE INTERVALS

Time Interval (p. m.)	Precipitation, Inches	Accumulation, Inches
3.30 to 3.45	0.13	0.13
3.45 to 4.00	0.18	0.31
4.00 to 4.15	0.39	0.70
4.15 to 4.30	0.52	1.22
4.30 to 4.45	0.16	1.38
4.45 to 5.00	0.07	1.45
5.00 to 5.15	0.12	1.57
5.15 to 5.30	0.64	2.21
5.30 to 5.45	0.39	2.60
5.45 to 6.00	0.22	2.82
6.00 to 6.15	0.03	2.85
6.15 to 6.30	0.16	3.01
6.30 to 6.45	0.74	3.75
6.45 to 7.00	0.51	4.26

tion of the precipitation over the drainage basin.

GLENWOOD DAM SURVIVES

The Glenwood Dam was built by the city across Mill Creek in Glenwood Park, on the outskirts of the inhabited area, about ten years ago. It consists of a hollow, reinforced concrete spillway about 35 ft. long, 6 ft. high, and 3 ft. below abutments, in the bed of the creek, flanked by earth embankments, 125 ft. long on the east end and 75 ft. long on the west end. The dam was completely overtopped during the flood, and water to a depth of about 4 ft. passed over the embankments. The west embankment was breached in two places, but to a depth only a little lower than the spillway crest. Contrary to press reports, the failure of the dam had nothing whatever to do with the flood in the city, since it was not only almost entirely submerged, but its storage capacity was negligible.

RATE OF DISCHARGE DETERMINED

With a 4-ft. depth over the earth embankment, the quantity passing the dam amounted to 7050 cu. ft. per second, or at the rate of 760 sec.-ft. per square mile for the tributary drainage area of 9.27 sq. miles.

A cross-section of the creek about 1500 ft. below the dam, and shortly below the site of the Elliot Street bridge, was used as a basis of computation by Kutter's formula. Slope measurements made by the Water Supply Commission of Pennsylvania at the

extraordinary flood losses. These were not only inadequate to carry the discharge, but soon became clogged with debris, causing the flood to pass over them or carry them away. At Twenty-sixth Street the street level was about 25 ft. above the creek, which flowed under it through a small brick culvert. This crossing acted as a dam until water passing over it carried the bridge approaches away, causing a rush of water below and great damage. This was repeated at successive bridges, causing a great increase in the height of the flood water. About twenty-five bridges cross Mill Creek in the city limits, and all but three or four of these were either destroyed or new channels cut around them. About thirty highway bridges were destroyed in the country districts.

Several important manufacturing establishments were built over the creek, forming complete obstructions. The water swirled around these plants, clearing away all frame buildings and causing a complete ruin of all material, machinery, etc., in the ground floors and basements of the factories.

Railroad traffic was suspended for a period as the result of washouts and the destruction of bridges. The Nickel Plate Railroad crossing over Mill Creek in Erie was destroyed, the small concrete culvert which was built to carry the stream proving entirely inadequate. Severe erosion of the fills and roadbeds of the railroads attested to the intensity of the rain.

Fourmile Creek, near Erie, flooded in a manner similar to Mill Creek but was not so obstructed, and did little damage other than the destruction of a few bridges. Neighboring communities reported damage of lesser importance indicating that the precipitation covered a fairly wide area.

This is the third great flood in Mill Creek of which record has been obtained, and it is

to be hoped that there may be truth enough in the superstition regarding the success of the third time to enable the city to construct works to prevent a fourth occurrence.

On Sept. 10, 1878, the first flood came, and several people lost their lives, while much property was damaged. The population of Erie was small then, only 28,000 as compared with 75,000 to-day. The channel was not so much encroached upon and the losses were much lighter.

In 1893 came the second inundation, causing much damage but no loss of life. Following this experience an attempt was made by some of the citizens to pass a bond issue to effect a remedy. It was unsuccessful, and now that still further reductions have been made in the channel capacity, still more valuable property and buildings placed in way of floods, still more lives put in jeopardy in houses in the flood zone, the penalty of procrastination has been paid.

We do not know how the discharge during the floods of 1878 and 1893 compared with that of Aug. 3, but we do know that the loss in this most recent one was far greater than in the others, and that this greater loss in life and property was due to ill-considered construction of buildings, bridges and culverts along and over the stream. Unfortunately the design of a small bridge usually consists in getting a structure to suit the traffic and purse, and its suitability to the stream which flows under it is seldom considered. Such a catastrophe as this accentuates the necessity for considering seriously this factor in bridge design. It also emphasizes the wisdom of thorough investigation before locating dwellings and factories in the flood plain of streams and rivers, and of preventing the construction of such buildings in locations which will reduce beyond safe limits the waterway capacity of the channels.

The failure of the 50-ft. concrete dam at Austin, Pa., on Sept. 30, 1911, resulted in the passage of a law by the Legislature of that State, providing for the investigation of the safety of every dam, and that no new dam could be built until the plans had been approved by the State Water Supply Commission. This law also provided for approval of plans for bridges, culverts and encroaching buildings or other structures.

Unfortunately the buildings and encroachments which caused the damage along Mill Creek were built before this law was enacted. Recently applications have come before the commission for the construction of culverts and buildings on and along this stream, and the engineers of the State have pointed out the necessity for leaving a large unobstructed channel, and have met with decided opposition.

Doubtless this difficulty will not now be encountered, and a thorough study will be made of the best way to lock the door securely now that the horses have been stolen. Just as it was necessary for seventy-eight lives and hundreds of thousands of dollars' worth of property to be sacrificed at Austin to teach the lesson concerning secure dams, so thirty lives and millions of dollars of property had to be lost to force home the necessity for intelligent supervision, by a disinterested body, of the occupancy of flood plain land and the adequacy of bridge openings.

THE AVERAGE COST OF 35.9 MILES OF HIGHWAY in California, for which contracts were awarded last month, was \$7,541 per mile.

Gains Made by State Management of Road Construction and Maintenance

J. E. Pennybacker Summarizes Progress—Urges Elimination of Politics and Shows Need for Uniform Legislation

IN support of his contention that the development of State road management has been toward a larger measure of participation by the State through increased appropriations and more comprehensive State supervision, J. E. Pennybacker, chief of road economics of the U. S. Office of Public Roads, gives in the 1914 Yearbook of the Department of Agriculture, statistics covering the more important State-aid work accomplished. Of the States which, for magnitude of expenditures, mileage of roads constructed, and comprehensiveness of system, stand out most prominently, Mr. Pennybacker has selected several for individual mention, so that the reader may obtain a more intimate knowledge of the operation of the policy of State management.

POLICIES OF LEADING STATES

Massachusetts, which established its highway department in 1892, had expended out of State appropriations to Jan. 1, 1914, about \$14,000,000, had completed more than 1000 miles of State highway, and had aided in the improvement of more than 350 miles of small-town highways. The State obtains its funds for road work through the issuance of State bonds and the levying of automobile license taxes. In constructing the system of State highways the entire cost is borne in the first instance by the State, but the counties are required to repay to the State 25 per cent of the cost. The motor-vehicle fees are applied entirely to the maintenance of State highways and improvement of small-town roads.

Connecticut, which established its highway department in 1895, had expended to Jan. 1, 1914, about \$11,500,000, a portion of which was derived from the sale of State bonds. The aid granted by the State varies according to the taxable valuation of the towns, but has been usually from three-fourths to seven-eighths of the cost of the roads on which the State has granted aid. Like Massachusetts, the Connecticut system provides for the application of automobile revenues to road maintenance.

New York established its highway department in 1898 and expended some \$25,000,000 of State funds additional to the authorization in 1906 of the first State bond issue of \$50,000,000 for road construction. A second State bond issue was authorized in 1912, amounting to \$50,000,000. This provided a total of \$100,000,000 through the issuance of bonds for the building of a system of State and county highways. The system as laid out divides the highways into four classes, namely: State highways, to be improved and maintained solely at the expense of the State; county highways, to be improved and maintained at the joint expense of the State, county, and town; county roads, improved and maintained by the county; and town highways, improved and maintained by the town with the aid of the State. The bond issue was originally intended for the improvement of a system of county highways aggregating 8380 miles, and to this was added a system of State highways of 3617 miles. Approximately 4300 miles of the State and county system were completed up to Jan. 1, 1914, with a

total outlay of State funds aggregating \$67,155,000.

VIRGINIA MAKES RAPID PROGRESS

Virginia has made rather remarkable progress, largely in the building of cheaper types of road than have been constructed in New York and the other Eastern States. The Virginia department was established in 1906 and had expended out of State funds to Jan. 1, 1914, a total of \$1,663,000. To show for this outlay, the State reported for the same period a total of 2052 miles of road constructed under State supervision. Under the Virginia plan the local contribution comprises one-half of the total cost, but many of the counties accept State convict labor in lieu of money aid from the State. The law also provides that bond issues shall be expended under the direction of the State highway department. The total mileage of roads constructed under the direction of the Virginia department exceeds the total reported by any State except New York and Michigan, and as the latter State grants aid on local roads only to the extent of a small reward or bonus, the mileage reported would not be comparable on the same basis as the mileage reported by the Virginia department.

Ohio established its highway department in 1904 and constructed to Jan. 1, 1914, a total of 578.29 miles at a total contract cost of \$4,847,768, or an average of \$8,383 per mile. Under the present law the State levies a tax of one-half mill, which provides an annual revenue of about \$3,500,000. In the expenditure of this fund the counties, townships, and abutting property owners must provide an equal amount, so that the annual outlay under the direction of the State highway department is now approximately \$7,000,000. A system of intercounty highways has been laid out connecting all of the county seats in the State, and this system is rapidly being improved and maintained under the direction of the State highway department.

Maryland is engaged in the construction of a system of State highways about 1285 miles in length, to be constructed and maintained entirely at the expense of the State. Bonds have been issued and authorized by the State to provide the necessary funds. The total thus issued and authorized to Jan. 1, 1914, amounted to \$9,170,000. During 1914 additional issues were authorized, bringing the total up to something like \$15,770,000, and it is estimated that the entire system will cost approximately \$18,000,000. The total mileage of the State system completed to Jan. 1, 1914, aggregated 490 miles. The State has been granting aid toward the improvement of roads since 1898, and the total of roads completed on which the State has paid a part or all of the cost to Jan. 1, 1914, aggregates 1430 miles.

NEW JERSEY PIONEER IN STATE AID

New Jersey, which has the distinction of being the first State to adopt the policy of State aid, began its work in 1892 and had made a total outlay to Jan. 1, 1914, of about \$5,800,000. The State had completed

during that period 1833 miles of road, partly paid for out of State funds and partly by county funds. The State's contribution toward the total cost aggregates about 40 per cent. Revenues derived from the registration of motor vehicles are applied to the maintenance of the roads, and recently provision has been made for the laying out of a system of State highways similar to the plan adopted in many other States.

Wisconsin, which has been operating under a State-aid plan since 1911, follows a system somewhat local in character, under which the boards of county commissioners are required to select "a county system of prospective State highways." These roads are constructed by the town, county, and State, jointly, each paying one-third of the cost, or a county can assume two-thirds of the cost and the State one-third. The improvements are made under the direction of a county highway commissioner selected by the county board, under the general direction and in accordance with plans and specifications of the State highway commission. The first appropriation made by the State was \$350,000 in 1911, and a similar amount in 1912. For 1913 the appropriation was increased to more than \$800,000 and for 1914 to \$1,230,000. Under the joint township, county, and State plan more than \$4,300,000 is available for 1914. That rapid progress is being made is indicated by the fact that 996 miles of road were constructed during the year 1913, bringing the total constructed under the direction of the State highway department to 1436 miles.

California has undertaken to construct a system of State roads comprising two trunk lines traversing the State from north to south, and a system of laterals connecting the county seats with a trunk-line system. A State bond issue, amounting to \$18,000,000, was authorized in November, 1910, and the work of constructing this State system is now well under way. State highway bonds to an aggregate of \$5,200,000 were sold to Dec. 31, 1913, and contracts had been awarded for the construction of 356 miles of highway, estimated to cost about \$2,900,000.

COST OF ROADS

The cost of a road is dependent upon not only the type of construction, but the amount and character of grading to be done, the cost of labor and materials, the width and thickness of surfacing, the character and amount of drainage required, and other factors of equal variability. Based upon general averages, however, it has been ascertained that under average conditions macadam roads can be built in southern States at from \$4,000 to \$5,000 per mile, gravel roads at from \$1,500 to \$2,500 per mile, and sand-clay and topsoil roads at from \$800 to \$1,500 per mile. In New England and the other eastern States, macadam roads are reported at from \$6,000 to \$9,000 per mile, gravel roads at from \$3,200 to \$5,000, and bituminous macadam from \$8,000 to \$13,000, according to the character of construction, whether surface-treated, penetration, or mixing method. The bituminous type is quite general in the eastern States.

As indicating costs in other sections of country, the State Highway Commissioner of Michigan reported in 1913 the average cost for macadam roads \$4,300 per mile, clay-gravel roads \$1,500 per mile, and con-

crete roads about \$10,000 per mile. The average cost of State highways constructed in Ohio in 1913 was \$8,383. According to types, in 1912 the brick-paved highways averaged \$14,650 per mile and the macadam highways \$5,950. In California the first 356 miles of the State system of highways cost an average of \$8,143 per mile and consisted principally of thin concrete with a thin coat of bitumen. The maximum and minimum figures given in this paragraph are not absolute, but are intended to present the usual range of costs. The rates given include grading, drainage, surfacing and engineering costs.

EFFICIENCY OF STATE MANAGEMENT

The efficiency of State road management has been impaired in some of the States through the influence of politics. Changes of administration have brought about upheavals which have proved prejudicial to the efficient and economical administration of the highways. This condition is gradually being remedied through the placing of nonpartisan commissions in charge of State highway departments, so that in the appointment of highway engineers and their assistants political considerations shall have no weight. Furthermore, competent engineers may be attracted to the work by the realization that they will not be disturbed in office so long as they render efficient service.

MAINTENANCE

In the early stages of State road management little or no provision was made for the maintenance of roads constructed with the aid of State funds. This condition has developed into a serious problem, and many of the States are finding it difficult to obtain sufficient funds to resurface and properly maintain the large mileage of roads already constructed. It was thought at first that if the States aided in the construction of roads the counties could be depended upon properly to maintain them. This has been found to be a case of misplaced confidence, and the only way in which the States could obtain proper maintenance was to place the work under the immediate direction of a State highway department. Automobile revenues are for the most part applied to the maintenance of roads, and many of the States are providing annual cash appropriations in sufficient amounts properly to meet existing conditions.

STATE CONTROL

The realization has become quite general that, in order to render maximum service, State highway departments should be given some measure of control over the construction and maintenance of local roads. For this class of roads an amount exceeding \$160,000,000 is expended annually, with comparatively little result to show in the form of improved road mileage for this great outlay. The State of Iowa has met this situation by placing all the road work in the State under the direction of the State highway department.

Traffic is increasing so rapidly as to cause excessive wear upon the roads, especially in the vicinity of congested centers of population. This results in a heavy annual maintenance cost, averaging in the large eastern States not less than \$750 per mile per annum. Many experiments have been made in the effort to devise types of road which can be maintained at relatively low

cost. Thus far, aside from the cheaper forms of construction, the States are depending upon the various forms of bituminous macadam, concrete and vitrified brick road.

FEATURES OF SUCCESSFUL MANAGEMENT SUMMARIZED

Summarized briefly, the essentials to successful State highway administration, as demonstrated by the experience of the various State highway departments, are as follows: (a) The elimination of politics as a factor in State highway work; (b) the control by the State highway department of all work on which State funds are expended; (c) adequate appropriations for continuous maintenance of highways under efficient supervision from the day the highways are completed; (d) State supervision as to surveys, plans and specifications of roads and bridges constructed under bond issues, and supervision of such other road and bridge work as requires considerable cash outlay and the exercise of engineering skill and knowledge.

Highly desirable progress toward the attainment of efficiency in State highway management could be accomplished by a general revision of State road laws, so as to eliminate all obsolete and conflicting legislation and to reduce the really essential laws to a few simple, clear-cut statutes which would define duties and responsibilities and provide ways and means for conducting highway work. A literal compilation of the road laws of the several States has already been made. This great mass of legislation exceeds 4,000,000 words. It is difficult to imagine conditions in any State which would necessitate more than 10,000 words to deal adequately with all phases of highway improvement. If this average were maintained for the forty-eight States, it is evident that without any loss whatsoever in efficacy 3,500,000 words could be wiped off of our statute books.

CONCLUSION

State road management is a concrete manifestation of the universal demand of the age for efficiency and equity in the management of public affairs. Its advocates contend that only by State appropriations can the burdens of constructing roads of more than neighborhood importance be equitably apportioned; that only by reaching such adequate sources of revenue as are possessed by the State can sufficient funds be obtained to improve the roads commensurate with their importance; that only through the establishment of a State highway department can the best engineering and practical ability be obtained for the benefit of the entire State, as by any other plan only the wealthier counties could afford to obtain such assistance; that through this centralized management correlation of road work throughout the State may be obtained and the influence of local politics in some degree eliminated or modified; and that standardization as to methods, costs and administration may be greatly promoted by such centralized control. It must be said as evidence of the efficiency of this system that no State is on record as having permanently abandoned the policy once it has been adopted. The whole development of State road management has been toward a larger measure of participation by the State through increased appropriations and more comprehensive State supervision.

Minneapolis Loses Filter Infringement Suit

Gates Operated from a Single Position and Underdrains with Holding Down Screens in Tapered Bottoms Are Held to Be Inventions

THE filter patent litigation brought against Minneapolis by Ira H. Jewell has been decided in two of the eight claims in favor of the patentee, as noted in last week's issue of the Engineering Record, page 181. After a delay of more than a year Judge W. F. Booth of the fourth division of the U. S. District Court, district of Minnesota, handed down the decision. An abstract of a portion of the decision is given below:

The suit is in equity to restrain the city from constructing and using filters embodying inventions numbered 649,410 and 649,411. The answer of the defense was non-infringement, anticipation and absence of invention. At the final submission eight claims only were contested but they can all be summed up in claim 1 of 649,410, reading as follows: "A filter provided with a system of controlling valves which are provided with actuating devices located so as to be accessible for control from a single position of an operator," and claim 14 of 649,411 reading, "a filter comprising a tank having a tapered lower end, and an opening at the bottom of the same, a screen at the lower end of the tank in line with said opening, a granular filter bed within said tank, the part of said bed contained within the tapered portion of the tank being made of relatively large granules whereby water passing upwardly therethrough in washing the filter is laterally deflected so as to be distributed throughout all parts of the bed and a screen interposed between said larger granules and the part of the bed above the same."

OPINION ON SCREENS

In commenting on the difference between the cup-shaped strainers in the Hyatt patents and that proposed by the Jewell claim Judge Booth states as follows: "In the Hyatt structure the upper screen, or perforated metal, in its normal action is not intended to and does not hold the coarse material underneath in a rigid position. In the plaintiff's structure the upper screen in its normal action intended to and does hold the coarse gravel underneath in a rigid position. Further, on the assumption that the Hyatt structure may be so used as to wash the sand, without transferring it to a separate compartment, a considerable portion of the filter sand bed in the Hyatt structures is not directly and wholly above the coarse or granular material, and therefore, the water in the washing process in passing through the coarse material does not strike effectively the bottom portion of the sand in all parts of the filter bed. Accordingly, the bottom of the filter bed is more or less incompletely washed. In the plaintiff's structure, the idea and aim of the inventor was to have the sand bed of the filter directly and wholly above the coarse or granular material. This was accomplished by the tapering form of the lower part of the filter bed with gravel, above which rested the sand bed. Unwashed areas were thus avoided.

"This arrangement or combination, taken as a whole, in my judgment, was a real step in advance, and constituted invention. It is not claimed that plaintiff invented high velocity washing of filters, but it is claimed

that he so arranged the elements going to make up his filter structure (the tapering bottom, screen at the lower end with restricted openings, the filling of the tapering portion of the filter bed with coarse granular material, the holding it rigidly in place with an upper screen and the position of the sand bed such that all parts of it should be directly above the coarse granular material) that high velocity washing became a practical and efficient process. It was this final step in making the combination and organization above noted that constituted invention on the part of the plaintiff. It is easy to see now that the arrangement made by the plaintiff in his structure is a remarkably practical and efficient one to produce the desired result; but, no one saw it until after the plaintiff had himself taken the advance step.

"The zeal of counsel has collected quite a number of old patents which, it is claimed, embody every one of the elements of the plaintiff's structure, sometimes singly, sometimes in various combinations. It would serve no useful purpose to analyze in detail these various patents; it is sufficient to say that, in my judgment, the evidence shows that claim 14 of the plaintiff's patent was not merely a mechanical aggregation of old and well known elements, but a combination and an organization of elements in a structure which constituted a distinct advance in the art of filtration, and that the steps taken by plaintiff in bringing together and combining those elements were of such a character as to constitute invention."

OPERATING TABLES INFRINGE

Applied to the control feature the decision states that all of the claims but No. 1 of 649,410 refer to a central station for all of the filters and no such station exists at Minneapolis. Claim 1, however, was held to relate to a single filter unit. The anticipatory examples of the plants at Wilkes-Barre and Atlanta were equipped with hand-operated levers or hand wheels. On this point Judge Booth is of the opinion that the size alone of the Minneapolis filter, leaving efficiency out of the question, makes a different device necessary than is used at these other cities. It was urged by the defendant that the change from hand operated to power operated valves did not involve invention and that the substitution of hydraulic valves was but a double use for an old device. Judge Booth declared as follows: "This raises a question, which under the evidence and the authorities cited, to my mind, is not free from doubt, but I think that the doubt should be resolved in favor of the plaintiff. The patent was granted, claim 1 being included, and this raises at least a presumption of invention."

MINNESOTA SPENT \$1,464,773 on road and culvert construction, \$323,111 on road maintenance and \$236,236 on bridge construction during 1914, according to G. W. Cooley, State engineer, in his latest annual report. The total amount of work supervised by the State Highway Department during 1914 was \$4,809,792. The cost of supervision on all the work amounted to approximately 5½ per cent.

Wrecked Ship's Backbone Broken with Dynamite

How Divers Placed Charges in Removing Steamer Sunk Last Winter in Ice Floes off Entrance to Chicago Harbor

DYNAMITE charges carefully placed by divers were the main factor in removing the wreck of the steamer "Iowa," which was sunk in the running ice about 2 miles off the entrance to the Chicago harbor Feb. 4, 1915. The passengers and crew were saved by walking to shore on the ice. The upper works of the ship were badly torn away, causing the hull to roll over as it sunk.



DIVER GETTING READY TO GO DOWN

The depth of water in the vicinity of the wreck was 36 ft., and the depth over the wreck was 16 ft.

The vessel, which was built in 1896, was made of wood. It was 202 ft. long, 36 ft. wide and of 13-ft. draft, and had a gross tonnage of 1157 and a net tonnage of 846. Part of the cargo was salvaged by the owners, the Goodrich Transit Company of Chicago.

FORTY DAYS TO REMOVE WRECK

Contract for the complete removal of all parts of the wreck to a clear depth of 30 ft. below datum was awarded in Chicago May 21 to the Great Lakes Dredge & Dock Company by Lieut.-Col. W. V. Judson, Corps of Engineers, U. S. A. The specifications and contract provided that the work should be commenced within ten days after the re-



DIVER IN HIGH DIVE

cept of the approved contract agreement, and that the whole job should be completed within forty calendar days after the date set for the commencement of the work. Liquidated damages in the amount of \$100 per day for any period of delay beyond the allotted time were provided. The contract also required that no material removed should be deposited in the lake where the depth of water was less than 60 ft. or where there was less than 35 ft. clear depth. It further specified that all floating material be secured and disposed of otherwise than in the water.

DIVERS MAKE INSPECTION

On June 1 divers made an inspection of the wreck and reported that the boat was lying upside down, that her bow was pointed toward the harbor and that the north side of the hull was raised 4 to 5 ft. off the lake bottom by broken parts of the bulwarks and by part of the cargo which had been carried on deck. For the next few days the divers worked placing dynamite racks and salvaging such parts of the cargo as could be reached. The cargo consisted mostly of tanned leather hides and parts of machinery, including electrical equipment, gears and castings.

BREAKING THE SHIP'S "BACKBONE"

The divers formed a trough 1 ft. wide, from stem to stern on both sides of the upturned keel, by setting 2 x 4 in. scantlings on edge and spiking them along the bottom of hull about 1 ft. away from and parallel to the keel. Sacks containing 50 lb. of dynamite were then lowered into place in the trough at 10-ft. intervals, alternating on either side of the keel so that the distance between sacks on each side of the keel would be 20 ft. Wires extended up through the water to small floats. Five sets of these blasting wires were connected by lead wires to a battery about 500 ft. from the wreck. Five bags of 50 lb. each, or 250 lb. of dynamite, set and located as described, were set off in each blast. The blowing up of the stem piece and bow required an additional blast of 250 lb.

No sand bags, mattresses or other devices for holding down the force of the explosion were used, the water itself acting as a cushion. The force of the explosion can be readily seen and estimated from the volume of water thrown, as indicated in the accom-



LETTING DYNAMITE SACK DOWN TO DIVER

panying photograph. The column of water rose to a height of at least 200 ft. and extended over an area the radius of which would be 400 ft. In fact, the first day the dynamite was exploded the work-boat was about 400 ft. away from the wreck and all of the men aboard were drenched by the spray and swell. The first blast of dynamite was handled by the diver attaching exploders, but later it was found better to have all the wires attached and have the diver only set the sacks.

The initial blast was shot on Monday, June 14, and the entire job was completed within three days of the time limit.

THE SIX AUTOMOBILES owned by the Wisconsin Highway Commission have traveled a distance of 88,100 miles in two years of road-inspection work. The total cost of automobile service, taking depreciation into account, was \$6378; the average cost per mile of operating the cars was 7.24 cents. The best showing was made by automobile 2, at an average cost of 5.6 cents, and the least favorable was made by automobile 5, which averaged 10.84 cents. The variances in cost per mile were largely due to the difference in the general conditions of the roads in the various road divisions.

Production of Rolled Iron and Steel Decreases in 1914

Gross Production Falls Off 6,421,047 Tons, or 25.9 Per Cent, as Compared with Output of 1913, Total Tonnage Being 18,370,196

THE American Iron & Steel Institute has recently published the figures for 1914 in special statistical Bulletin 4 of the Bureau of Statistics. The production of all kinds of iron and steel rolled into finished form (including blooms, billets and axle blanks rolled for forging purposes and semi-finished products which were rolled for export that year), shows a decrease of 6,421,047 tons, or 25.9 per cent, as compared with the output in 1913. The total gross tonnage rolled in 1914 was 18,370,196. It consisted of 1,945,095 gross tons of iron and steel rails, 4,757,814 gross tons of plates and sheets, 2,431,714 gross tons of wire rods, 2,031,124 gross tons of structural shapes not including plates and 7,204,444 gross tons of bars, skelp, and all other forms. Of the total tonnage, 1,167,776 gross tons were iron, and 17,202,420 gross tons were steel.

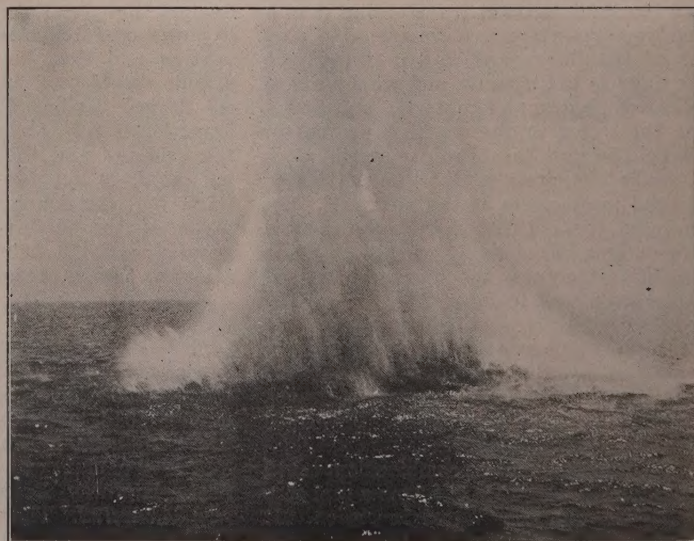
Items showing 288,471 gross tons of steel bars for reinforced-concrete work, 35,314 gross tons of rolled sheet piling and 33,249 gross tons of steel railroad ties are among those of interest to the engineer and contractor.

Skewed Joints Recommended for Concrete Road Construction

SKewed joints for concrete roads, instead of joints at right angles to the direction of traffic, are recommended by C. H. Moorefield and James T. Voshell, of the U. S. Office of Public Roads, in Bulletin 249 of the Department of Agriculture. With the joint at right angles the two wheels of a vehicle strike the joint at the same time and thus produce the maximum amount of impact. By skewing the joint at an angle of about 15 deg. the wheels strike one at a time, and the total resultant impact is reduced by at least one-half. This is advantageous to both the traffic and the pavement, and since the difficulties involved in constructing skewed joints are not at all serious, there is no apparent objection to their use, are opinions expressed by the bulletin.



CONNECTING LEAD AND FUSE WIRES



ONE OF THE SMALLER BLASTS

How Oiled Earth Roads Are Built in Kansas

W. S. Gearhart, State Engineer, Tells How to Get the Soil Ready, What Kind of Oil to Use, How to Apply It and the Equipment Needed

WITH but few exceptions—and those due to the use of a light oil—oiled earth roads have proved satisfactory in the twelve Kansas counties in which they were constructed, according to W. S. Gearhart, State engineer. Where a light oil was used it was found to act only as a dust preventive and not to form what is known as an oiled earth road. The following method of construction, says Mr. Gearhart, has given the best results.

GETTING THE SOIL READY

A shoulder furrow is plowed on each side of the roadway, making the width to be treated from 16 to 18 ft., and the loose earth is graded outside of this width. Where the crown of the road is too steep the center is plowed and the material thrown out to the sides. By plowing only the shoulders it has been found easy to shape the subgrade to a crown of about 1 in. to the foot. Practically the same care is exercised in preparing the subgrade for oiled earth road work as for macadam. After shaping the subgrade is thoroughly rolled to compact the earth as well as to take the spring out of the ground. The use of the solid shoulder is to prevent the oil from spreading and to facilitate the mixing and tamping process.

Sandy soils were found to be best adapted to the oil treatment, but satisfactory results are being obtained on clay and heavy gumbo soils where the earth is thoroughly pulverized.

GRADE OF OIL USED IMPORTANT

The grade of oil to be used is much more important than the kind of soil. Light oils and those having a paraffin base have been found to be little better than so much water. The oil should be one having an asphalt base of at least 85 per cent. It should be free from paraffin and all lighter oil, and applied to the road at a temperature of not less than 250 deg. Fahr. An oil containing 85 per cent of asphalt will have to be heated before it can be taken from the tank cars which have special steam coils for this purpose. It is necessary to heat the oil to a temperature of 340 deg. Fahr. in the car in order that it may be delivered on the ground at a



FINISHED OILED EARTH ROAD

temperature of 250 deg. Fahr. This will require a steam pressure of 100 lb. per square inch. The amount of oil used is from 2 to 3 gal. per square yard, and should be placed in two courses.

HOW THE OIL IS APPLIED

After applying $1\frac{1}{4}$ to $1\frac{1}{2}$ gal. of oil on the rolled subgrade, sufficient earth is graded on top of the oil to absorb it. For treatment of $1\frac{1}{2}$ gal. to the square yard about 4 in. of loose, fine earth is graded in on top of the oil, and then thoroughly soaked with water distributed from a sprinkling wagon, and the tamping process begun. A disk harrow, with blades set at an angle, and a drag are employed to stir and mix the oil with the earth. The harrow and drag precede the tamping roller. As soon as the first course is thoroughly mixed and rolled another application of $1\frac{1}{2}$ gal. of hot oil per square yard is applied and about 4 in. of fine earth graded in upon it, and the oil and earth thoroughly mixed and rolled as before. The amount of earth used should be just enough to absorb all of the oil. When the tamping roller rises to the top and the surface has been thoroughly compacted a water-tight wearing surface of from 5 to 6 in. thick will have been formed. The rolling is done from the sides to the

center, the same as in macadam construction, in order to maintain the crown.

Should any surplus oil come to the surface after the travel has been allowed on the road a small amount of loose earth is thrown on in order to absorb it, and the surface of the road may be made more durable by the application of 1 in. of sand or gravel.

EQUIPMENT NEEDED

The greater part of the work of preparing the road for treatment can be done with a traction engine and a road-grader. The earth can be thrown back either by a road grader or a road leveler, the latter being much more rapid and leaving the road in almost a perfect cross-section. The oil should be hauled in a distributing wagon built for that purpose, which holds about 600 to 800 gal. It will require two teams to haul such a wagon. One or two teams will be required on the disk harrow and two teams on the tamping roller. The work of grading the earth on the oil is followed closely by the placing of the oil, to prevent it cooling and to assist in the mixing.

There is very little danger of using too much water. The wetter the materials the more thoroughly the oil and earth can be mixed. Oiled earth roads cannot be constructed successfully without thoroughly pulverizing the earth. Treating the surface with oil is not satisfactory, says Mr. Gearhart, except for laying the dust, and this is only effective for a short time. Oiled earth surfaces are not satisfactory for city streets on account of the oily dust. In Kansas the actual cost of the materials and the construction of oiled earth roads as recommended above is from 10 to 20 cents per square yard, averaging about 15 cents.

ONE HUNDRED AND SIXTY-THREE CONTRACTS had been awarded prior to 1915 by the Board of Water Supply for furnishing materials and constructing New York City's additional water supply system. Of these, sixty-one had been completed by the end of 1914. Only a few of the larger construction contracts remained to be completed at the beginning of 1915. These were the Ashokan and Kensico dams, the Hillview reservoir, parts of the Yonkers siphon and the city tunnel, the supplementary shaft and tunnel of the Moodna siphon, the Narrows siphon and the Silver Lake reservoir with parts of the Richmond conduit.



OIL APPLIED AND READY FOR MIXING WITH EARTH



TAMPING ROLLER CONSOLIDATES ROAD SURFACE



DRAFT-TUBES DISCHARGE INTO UNLINED TAILRACE TUNNEL

Swedish Government Builds Hydroelectric Plant Above the Arctic Circle—Part 2

Local Conditions and Necessity of Protecting Conduits and Forebay from Freezing Resulted in Use of Underground Station

IN the first part of this article, published last week, page 156, there was a description of the dam system of the Porjus hydroelectric plant, the station north of the Arctic Circle, recently completed by the Swedish Government. Among the interesting features of the dam system were the measures taken to protect the structures from damage by ice, the use of a sliding wedge of stone to balance the earth pressure against a core wall and of arch decking for a hollow reinforced-concrete dam. This, the concluding part of the article, gives details regarding the hydraulic end of the station, which is entirely underground, and of the conduits and forebay. The last named, taken in conjunction with the equalizing, or surge, chambers on the tailrace tunnel, is of special interest.

INTAKE

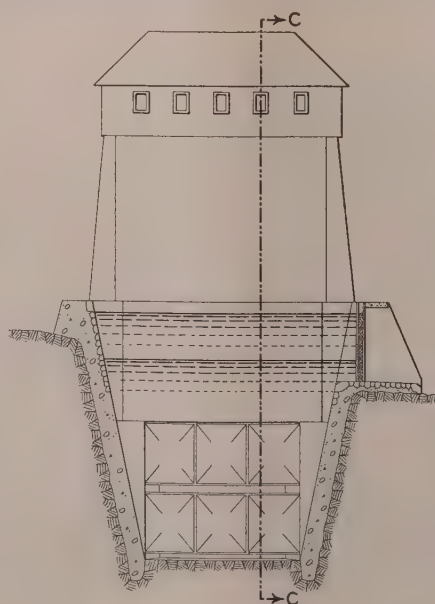
The intake, as was shown in the drawing in Part 1 of this article, is located at the east abutment of the dam, and is built integral with it. There are four openings, each 36 ft. wide and 14.8 ft. high, two for the first installation, now completed, and two for the second. Behind the gates are inclined racks, made of bulb bars spaced 4 in. on centers and supported on a structural steel frame. Stop-log slots allow each gate to be isolated for inspection.

Behind the screens is a basin connecting the broad but shallow section at the screens with the narrower but deeper part in front of the intake tunnel.

The gate controlling flow into the tunnel is about 65 ft. in front of the tunnel intakes. The design of this gate is shown in a drawing herewith. It is 24.6 ft. wide and 21.9 ft. high, suspended from chains and operated from a bridge above. In open position it is protected by an inexpensive timber housing. The gate consists of three horizontal trusses, supporting vertical beams, which carry the buckle-plate skin plate. The hydrostatic pressure on the gate is transmitted to the tracks by eight 2.46-ft. wheels, four on each side. In order to get

an equal distribution of the pressure on all wheels, they have been mounted in pairs on equalizers having their bearing pins fastened to the side girders of the gate.

Tightness is insured along the bottom by a timber bolted to the gate. At the sides and along the top there are loose wooden strips, fastened to the gate by springs, and forced against steel strips in the masonry by the water pressure. No by-pass has been deemed necessary. Should it be required to open the gate when the intake tunnel is empty and the basin filled with water, it can be done by opening it a few inches and waiting until the pressures are balanced. To enable the opening of the gate these first few inches, two screw-jacks, which can be attached to the operating chains, have been provided on the overhead bridge. Although the gate has been designed for hand operation, provisions have been made for



THIS GATE ARRANGEMENT CONTROLS FLOW TO TUNNEL INTAKE

electrical operation should this be found advantageous.

INTAKE TUNNEL

The intake tunnel, with a net area of 538 sq. ft., has been blasted through rock, which did not require lining except for 425 of the 1725-ft. length. Its slope and location are such that its whole length is below the hydraulic gradient. This was done so as to enable the utilization of the full section at all stages of water and all loads on the station. The slope is 1 : 800, which approximately, corresponds to the loss in head at maximum discharge.

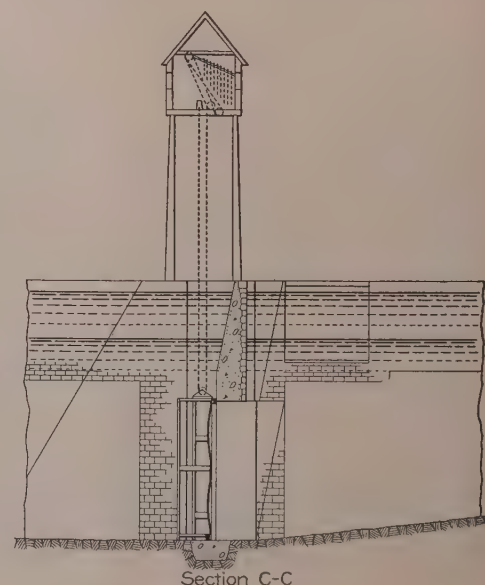
In the section requiring lining a wide fissure filled with clayey material and surrounded by loose and deteriorated rock was encountered. In blasting this section it was necessary to timber the roof. As the fissure appeared again in the excavation for the generator room, it was important to prevent the water from finding its way through it. It was, therefore, necessary to design a lining which would not permit any leakage. The arch was provided with double reinforcing.

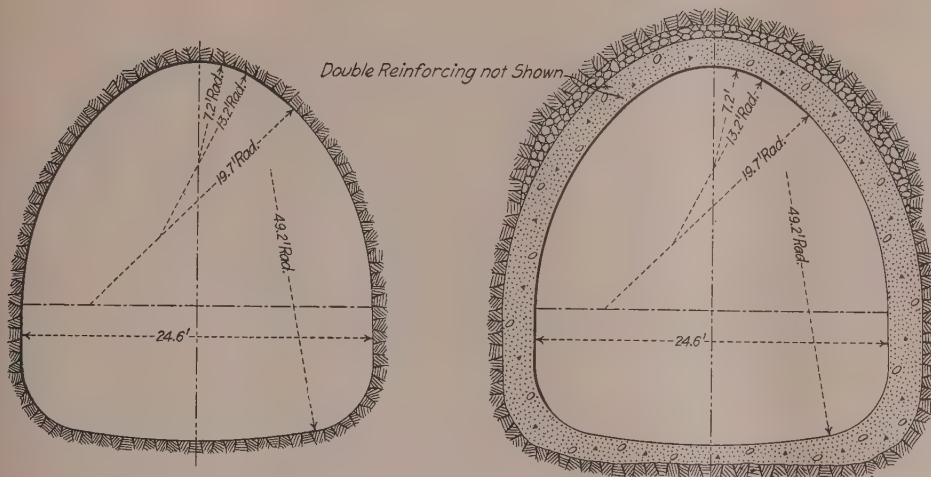
FOREBAY

For developments like that at Porjus, where the discharge is carried to and from the turbines in long and closed conduits, subject to sudden fluctuations, it is important to determine carefully the area of the forebay and of the equalizing chambers, which have been provided on the discharge tunnels. The load fluctuations at Porjus are sudden and large, because the greater part of the power is used for traction.

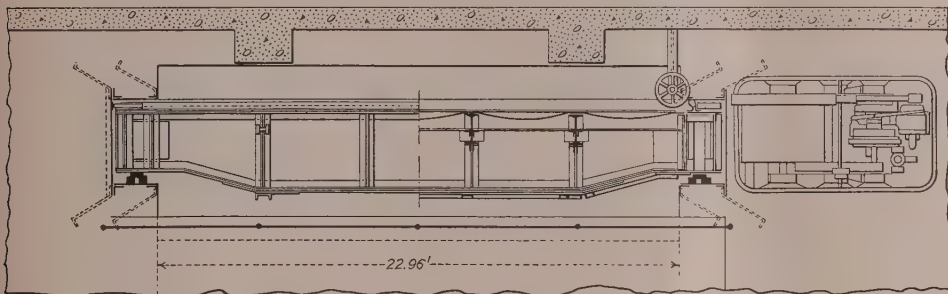
Basing the calculations on load diagrams of electric railways, it was determined that the maximum load changes possible will correspond to an increase or decrease in discharge of about 320 sec.-ft. The area of the forebay is 11,300 sq. ft. and of the equalizing chambers 7500 sq. ft.

In the diagram on page 195 is shown the result of such an increase—the surges for an increase from 750 to 1070 sec.-ft. The surges on the intake side represent the action in the forebay. On the discharge side of the turbines, the fluctuations in head, because of the wave action in the forebay, will create another set of waves or surges. These will begin with a sudden increase, at about the same time as the first lowering



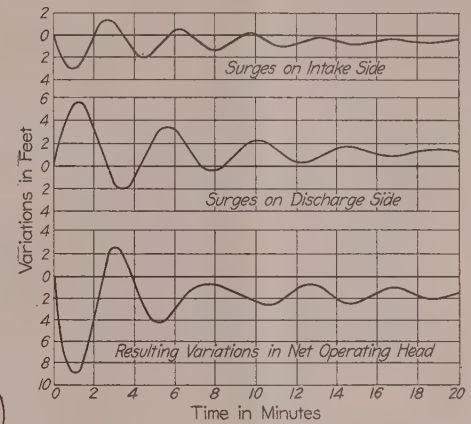


BAD ROCK CONDITIONS NECESSITATED LINING OF SOME PARTS OF INTAKE TUNNEL

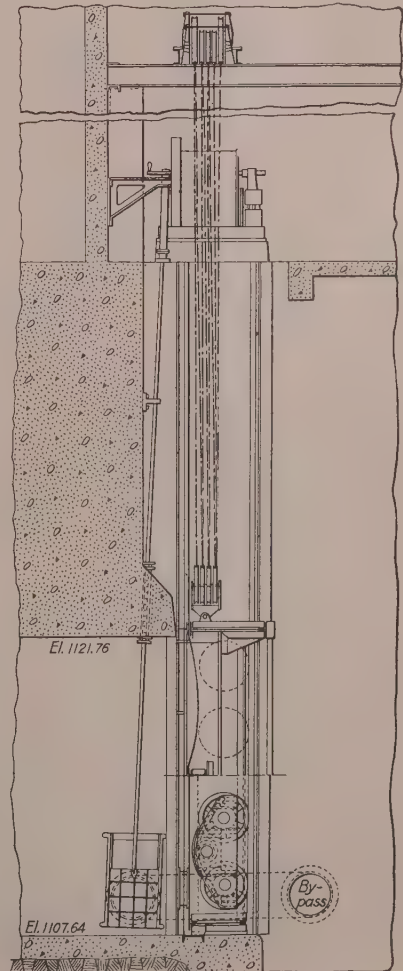
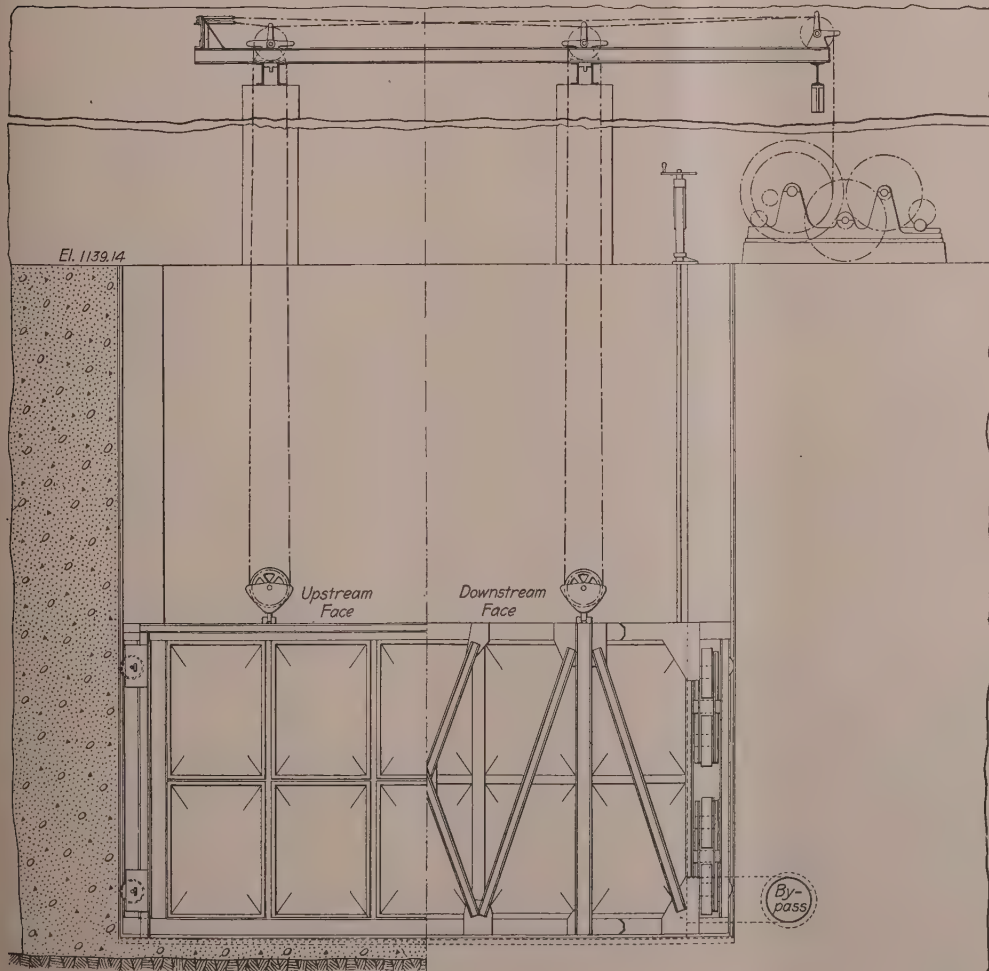


of the water surface in the forebay. As shown, the maximum decrease in head, due to increase in load, amounts to 8.85 ft. and occurs about 1 min. after the change in load. The variation in head is so slow that it does not influence the speed of the units, which, as usual, have been provided with automatically operating governors.

Should a sudden decrease in discharge of 320 sec.-ft. take place, the surges are about the same, the only difference being that the surges increase the head. Should an accident occur so that the decrease in discharge should amount to more than 320 sec.-ft., the surges will be greater than shown. The worst case would be a decrease from 1070 sec.-ft. to nothing. In such a case the water surface in the forebay will rise until water begins to spill over the overflow,



SURGES DUE TO LOAD VARIATIONS



THESE GATES ARE IN FOREBAY CONTROLLING FLOW TO VERTICAL PENSTOCKS

which is connected to the tailrace tunnel by a vertical shaft.

For the calculation of these waves and their corresponding intervals, the engineers have used the method devised by Prof. Fr. Prazil of Zurich, Switzerland, and that of R. D. Johnson of New York. Mr. Johnson's method was described in the "Proceeding" of the American Society of Mechanical Engineers, 1908.

DETAILS OF FOREBAY

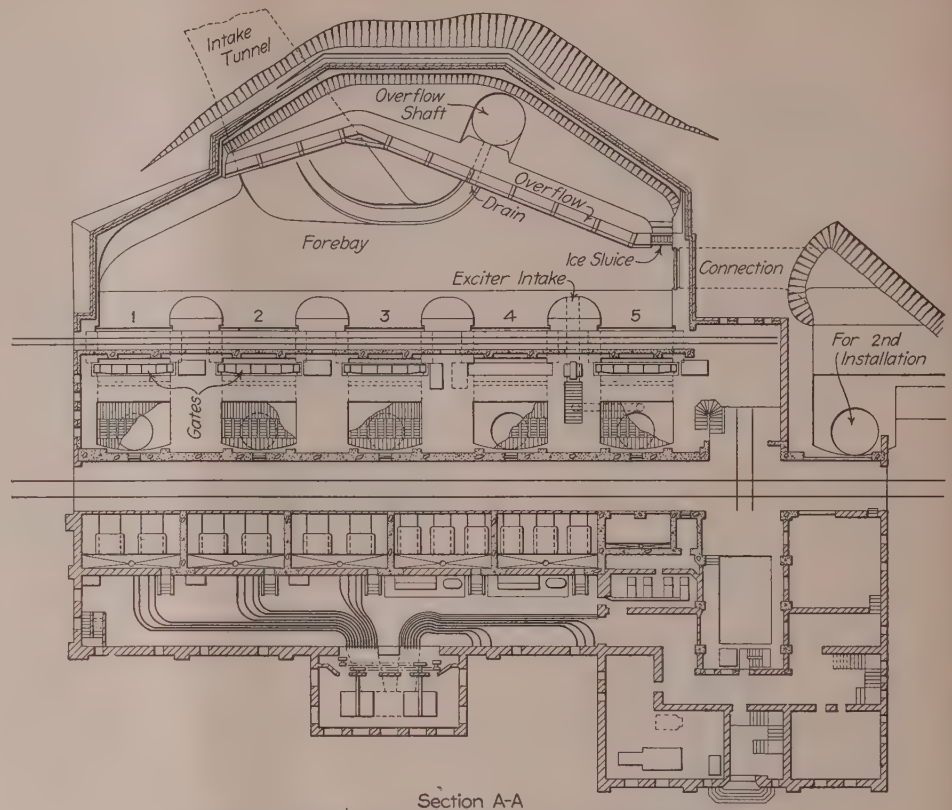
The forebay arrangement is clearly shown in accompanying drawings. To enable the intake tunnel and the forebay to be drained, the latter has a depression running from the end of the tunnel to the face of the overflow. A 2.5-ft. pipe, closed by a hand-operated gate, connects this depression with the overflow shaft.

It is of interest to note that when water is discharged it sometimes fills the entire area of the shaft, thus drawing the air with it. The action, therefore, is similar to that of an enormous vacuum pump. It has been found necessary to build a monitor on the roof so that air is admitted freely. This arrangement serves also for the ventilation of the equalizing chambers of the tailrace tunnel.

The overflow is a stone-set spillway, 150 ft. in length. Its crest is at the same elevation as the high-water back of the dam, i.e., 1134.88. At its south end there is an ice sluice, 5.75 ft. wide, with the crest at el. 1122.74. This opening is closed by stop logs up to the crest of the spillway.

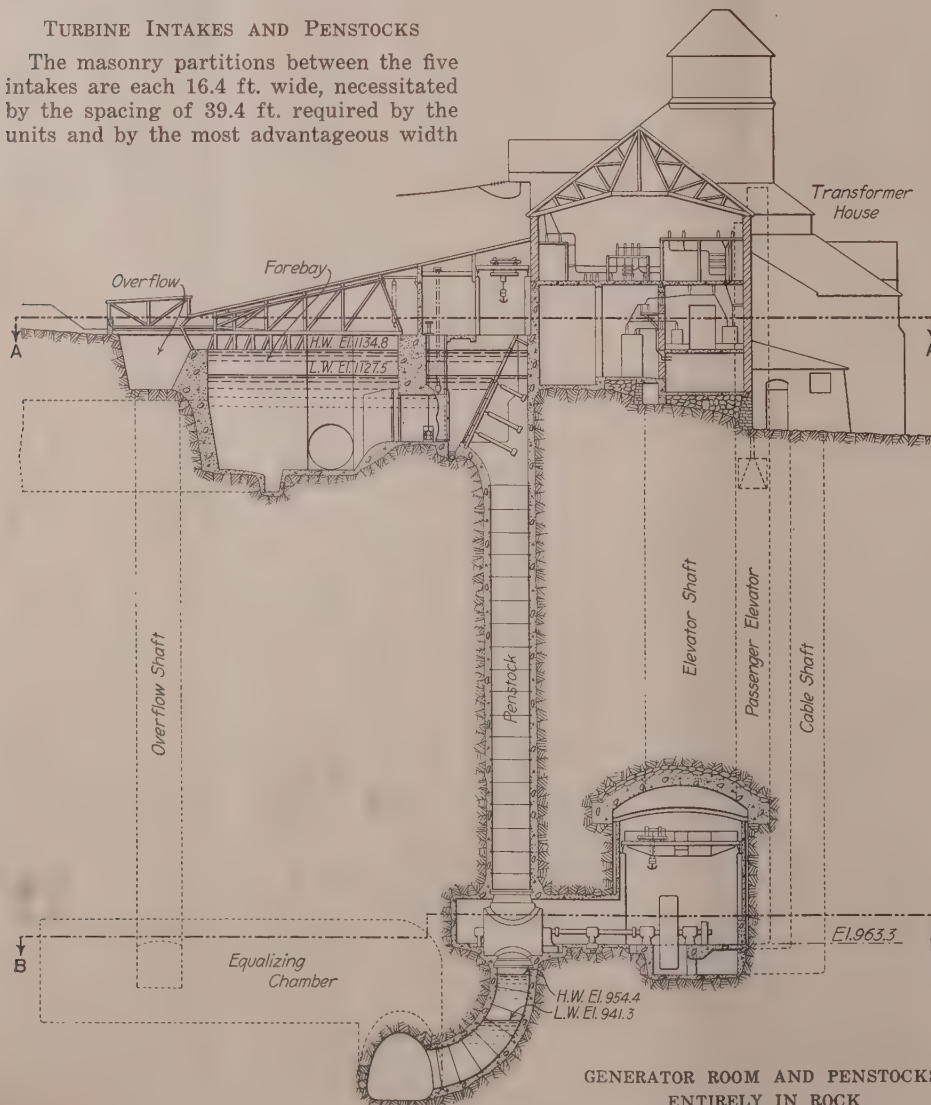
TURBINE INTAKES AND PENSTOCKS

The masonry partitions between the five intakes are each 16.4 ft. wide, necessitated by the spacing of 39.4 ft. required by the units and by the most advantageous width



Section A-A
LARGE COVERED FOREBAY ADJOINS TRANSFORMER HOUSE

For location of this section see vertical cross-section below.



GENERATOR ROOM AND PENSTOCKS
ENTIRELY IN ROCK

of the intake chambers, which is 23 ft. Originally, it was intended to let as much as possible of the rock remain as a core in these piers, but the quality encountered made this impossible. The piers are, therefore, made of concrete, with a very lean mixture in the center portions.

The intake for the exciter penstock is located in the pier between units 4 and 5.

Each turbine intake is closed by a single steel gate. The free opening is 23 ft. wide and 13.1 ft. high. The gates, which are shown in detail, consist of plate-girder frames with beam verticals and buckle-plate skin plates. Wheels and provisions for tightening are the same as for the gate at the intake end of the tunnel. Pipes have been provided in the concrete around the gate slots so that, should it be found necessary, steam can be used for thawing out the gates.

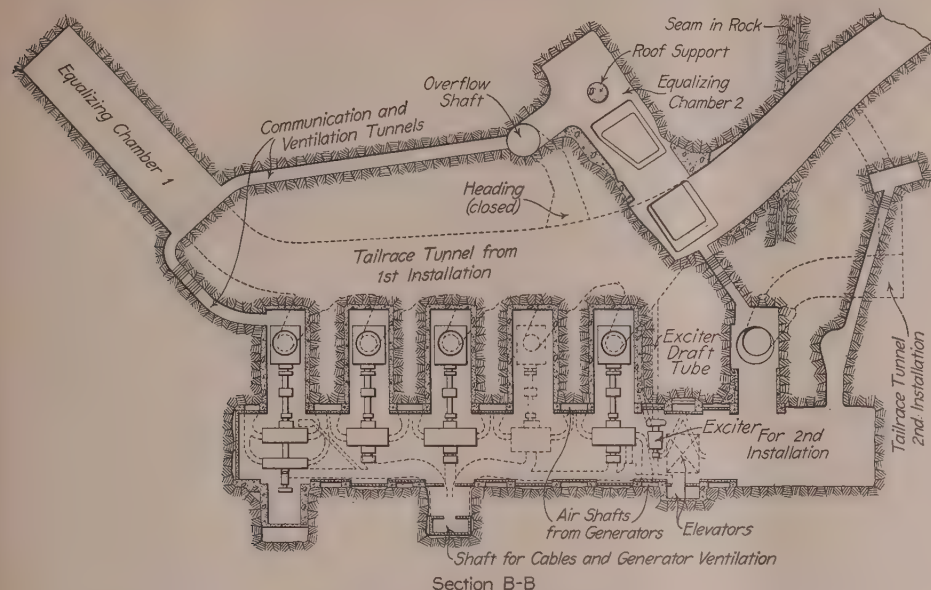
Inside of each gate is a groove connected by a pipe with the tailrace tunnel. This groove serves to collect leakage, when the gates are closed, thus permitting inspection of the turbines.

RACKS AND PENSTOCKS

The racks, just behind the gates, have been so arranged, that, should it be found desirable, they can be heated electrically in the same manner as is now successfully done at the Trollhättan plant in Sweden. The reasons why heating arrangements have not been provided from the start is that in this development, with its covered intake conduit and large reservoir, no troubles of this kind are anticipated.

Above the racks is a crane which serves the turbines, and runs out over an extension at the south end of the building, to which the machinery parts are brought on cars.

The penstocks, which are 11.5 ft. in diameter, are lined with steel plates, varying in thickness from $\frac{1}{4}$ in. at the upper end to



EQUALIZING, OR SURGE, CHAMBERS ARE PROVIDED ON TAILRACE TUNNEL

For location of this section, see vertical cross-section, page 196.

13/16 in. at the lower. The space between the steel lining and the rock has been filled with concrete. This filling has been provided with vertical drains, to prevent hydrostatic pressure on the outside of the penstock, when they are empty.

The exciter penstock is 2.8 ft. in diameter, made of plate steel from $\frac{1}{4}$ to $\frac{5}{16}$ in. in thickness. The intake, as above stated, is between units 4 and 5, but the penstock is turned to the right hand and carried through the shaft for the penstock of unit 5. It is then carried still further to the right, the exciter set being placed beyond that unit.

GENERATOR ROOM

The general layout of the generator room is shown in the accompanying plan. Its width is 36 ft., its height 37.7 ft. and its present length 312 ft. As mentioned before, the spacing of the units is 39.4 ft. on centers. The recesses for the turbines are 49.2 ft. deep, 19.2 ft. wide and 13.1 ft. high.

As shown on the cross-section, the generator room has a false ceiling. The space here created and also the spaces between the rock and the side walls are used for conveying the heated air from the generators. Cold air is forced down through the cable shaft and conveyed to the generators through ducts in the floor. From the generators the heated air is carried through another system of ducts to spaces back of the side walls and rises in them to the chamber above the false ceiling. This in turn is connected to the elevator shaft, and thus to vents in the tower on the transformer house.

The heated air, which, as stated above, passes between the rock and the side walls, prevents condensation. In winter, when the air is too cold to be conveyed directly to the generators, it is heated by mixing it with the heated air. When this is necessary the heated air is not conveyed through the conduits but is discharged, through ventilators, into the generator room. It then passes through the elevator shaft to the floor of the transformer house, where the fans mix it with the cold air and force it down to the generators.

The floor of the generator room is at el. 963.3, which is about 165 ft. below the surface of the ground and about 8.8 ft. above the high-water level at the discharge

end of the tailrace tunnel. Because of friction losses in the tunnel and heavy surges, it is possible that the water pressure in the upper end of the tailrace tunnel, in exceptional cases, may correspond to a fictitious water level above the floor of the generator room. It was not possible to locate the floor above the fictitious elevation, as its location is determined by the proper suction limit of the draft-tubes at low water. In order to prevent flooding of the floor, the cable conduits and the generator pits, it was necessary to waterproof the entire foundation of the generator room. The rock was covered with a course of concrete; a coat of cement plaster, containing "Ceresit," was applied, and a system of drains was provided before the concrete floor was laid. These drains terminate in a pit, from which the leakage is pumped.

UNITS

Five large units have been provided for in the first installation, of which, at present, units 1, 2, 3 and 5 have been installed. Of the units now in place, 2 and 3 are for railway traction purposes. They have a maximum capacity of 12,500 hp., run at 225 r.p.m., and are directly connected to

single-phase, 4100-volt, 15-cycle generators. The normal output of these units is 6250 kva. each at a voltage of 4100. Their maximum output each, however, is 10,000 kva. at a voltage of 4150. Unit 5 will furnish the power to the mine fields. Its normal capacity is 12,500 hp., and its maximum 14,000, at a speed of 250 r.p.m. The generator is a 3-phase, 11,000-kva., 10,000-volt, 25-cycle machine. Unit 1 is for emergency use. On its shaft are two generators, one single-phase and one three-phase, so arranged that either one can be driven by the turbine. In this way the unit serves as spare for either kind of current.

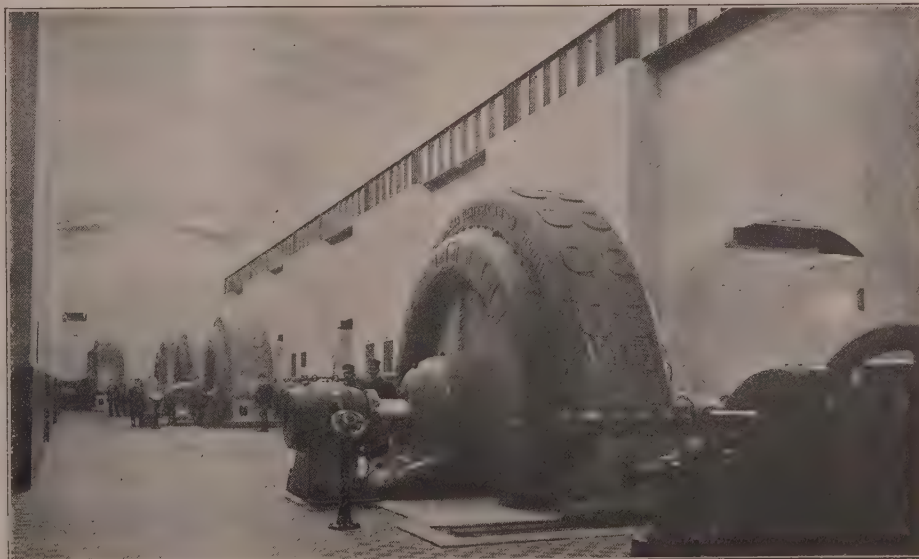
The turbines have been designed and built by Nydqvist & Holm of Trollhättan, Sweden, the same firm that delivered the turbines for the Trollhättan development. They have double runners, encased in cylindrical cases of plate steel with ends of steel castings. These cases have been designed and tested for a hydrostatic pressure of 377 lb. The draft chests are made of cast-iron and are connected to plate-steel draft tubes, concreted in the rock. The operating ring and the wicket gates are of cast steel. Between turbine and generator there is a short piece of shafting, supported on a third bearing and removable. When this short piece of shafting and its bearing are removed, there is sufficient room for taking down the turbine, without disturbing the generator. All bearings are water cooled.

The exciter unit consists of a 525-hp., single-runner, scroll-case turbine, running at a speed of 500 r.p.m., direct connected to a 350-kw., 220-volt, direct-current generator. Its scroll case is of cast-iron, while all other parts, including the runner but excepting the shaft (which is of rolled steel), are of cast steel. This unit is governed by an oil-pressure governor assisted by a fly wheel and a bypass.

Each main unit has been provided with an oil-pressure governor, capable of regulating the speed of the unit as follows:

Per cent variation in load.....	100	50	25
Per cent variation in speed.....	15	6	3

The necessary pressure oil for the servomotors is supplied by belt-driven oil pumps, one for each unit. A central pumping plant, consisting of an electrically driven pump of sufficient capacity to supply two units at



THIS GENERATOR ROOM IS 165 FEET BELOW GROUND LEVEL

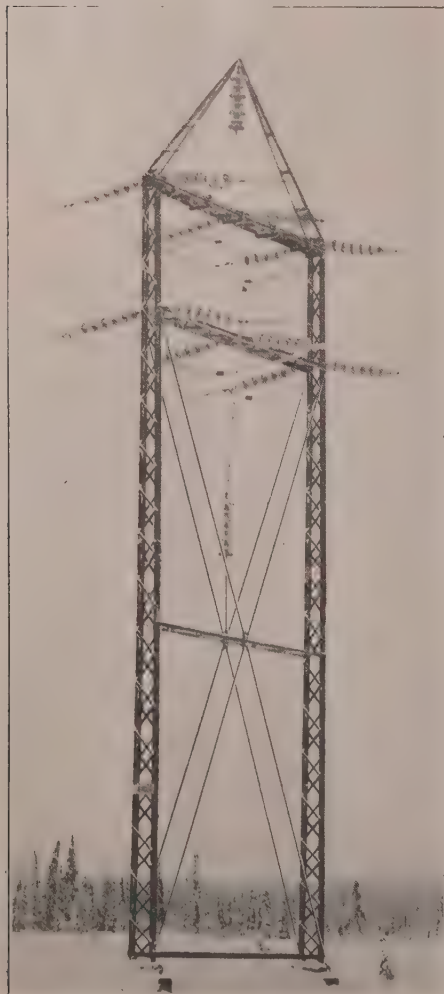
the same time, has also been provided. The oil-pressure tanks are partly filled with air in order to make them respond quickly. The pressure is 20 atmospheres, and the pressure air is supplied to all tanks by one compressor.

TAILRACE TUNNEL

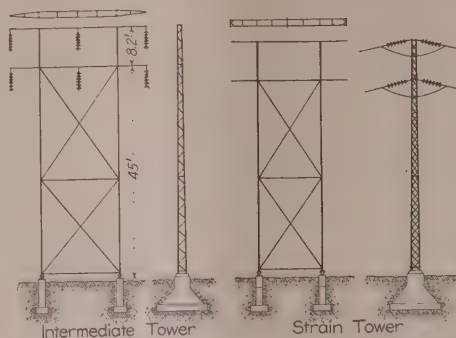
The length of the tailrace tunnel, center of the discharge opening of unit 1, is 4180 ft. Its net area (538 sq. ft.) and cross-section are the same as those of the intake tunnel. In front of the draft tubes, however, the area of the tailrace is larger. From the upstream equalizing chamber to the center line of the discharge end of the draft-tube of unit 1, the area is as stated above. In the distance between unit 1 to unit 4, the area is increased to 1076 sq. ft. This area is maintained until the tunnel has passed the second equalizing chamber, beyond which, in a length of 131 ft., it is again reduced to 538 sq. ft., which continues to the discharge end.

The reasons for enlarging the tunnel in its first part are to facilitate the flow of water to and from the equalizing chambers when surges occur, and to reduce the influence of eddies.

The equalizing, or surge, chambers are each 32.8 ft. wide and 32.8 ft. high. Their total area, in plan, is 7500 sq. ft. Their angular location was selected to conform with the cleavage planes of the rock. In order to permit inspection of the water levels in them, communication tunnels have been provided from the most advantageously located unit recesses. The vertical overflow shaft from the forebay discharges



STRAIN TOWER, PORJUS TRANSMISSION



INTERMEDIATE AND STRAIN TOWERS

into the downstream equalizing chamber.

At the discharge end of the tunnel both sides have been provided with stone-faced concrete walls with slots for stop logs.

MISCELLANEOUS

As already stated, the water supply at Porjus can be materially increased over that now available, provided the regulation of the watershed is carried out as planned. Provisions, therefore, have been made, so that the generator room can be extended, a second intake tunnel with a separate forebay built and another tailrace tunnel driven. Of this work only part of the intake at the dam and part of the excavation for units and generator room have been made. This had to be done in order not to interfere with the present plant, when the second installation is built.

The total cost of the first installation, including dwellings for the operating staff, real estate purchases, construction of roads, temporary hydroelectric plant for the construction, transmission lines, etc., was \$3,425,000.

The designs have been worked up by the Royal Swedish Waterfalls Commission, which also carried out the construction on force account. The chairman is Col. F. V. Hansen, who also supervised the design and construction of the Trollhättan development. The designs were in the charge, first, of G. Malm and then of A. Ekwall, assisted by K. A. Fröman. A. Westerlind was office engineer, in charge of construction, and the resident engineer at Porjus was A. Granholm, who was succeeded in 1913 by N. K. Sundlad.

Capacity of Scraper Misstated—Should Be Less

THE four-wheel scraper described in the article, "Operation Analysis of New Machines Which Cheapen the Moving of Earth on Road Work," by Prof. A. B. McDaniel, on page 126 of the issue of the Engineering Record for July 31, 1915, is stated in the table at the bottom of the left hand column, page 126, to have a capacity of 800 cu. yd. in 10 hr. Professor McDaniel advises us that this figure should have been 600 cu. yd. in 10 hr., and that all the units in this table should be calculated on the basis of 600 yd. This would make the total unit cost 10.7 cents, instead of 8 cents, as given.

A BRIDGE INVESTMENT of \$4,703,506.68 is reported in the latest annual report of the Sanitary District of Chicago. Of this amount nearly \$3,000,000 was paid for the thirteen bridges over the Chicago River and \$1,146,457 for fifteen Main Channel crossings.

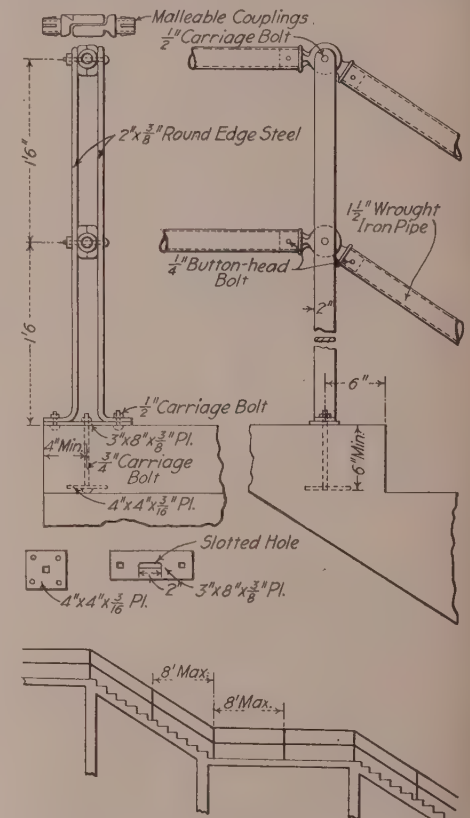
New Type of Gaspipe Railing Proves Satisfactory at Cincinnati

By EDGAR K. RUTH

Assistant Engineer—Structures, Cincinnati

THE Division of Structures of Cincinnati's Engineering Department has recently designed and erected on some of its new flights of reinforced-concrete steps an improved style of two-bar pipe railing with adjustable posts and couplings which is proving very satisfactory.

The city is rapidly replacing the large number of flights of wooden steps scattered through its hilly sections with reinforced-concrete construction. Landings are provided at frequent intervals and the slopes of the flights vary somewhat according to the topography. For this reason a railing was needed which could be readily adjusted



NEW TYPE OF GASPIPE RAILING CAN BE READILY ADJUSTED TO FIT ANY FLIGHT

to fit any flight, and which could be erected easily and in true alignment.

DETAILS OF RAILING

The details of the railing, which is 3 ft. high, are shown in the drawing. Expansion is provided for by omitting on the lower side of every fifth post the $\frac{1}{4}$ -in. bolts which connect the two rails to the post couplings, and by giving a $\frac{1}{4}$ -in. clearance between the ends of the pipe and the shoulder of the couplings at these points.

Whenever the direction of the railing does not change at a post the coupling for the lower rail is omitted and the pipe made continuous for two panels and bolted directly to the post plates.

All parts of railing, including bolts and couplings, are heavily galvanized.

Until recently the fence complete, including galvanizing, has cost the city about \$1 per linear foot, erected, but the present high cost of spelter has considerably increased the cost of galvanizing.

Direct-Lift Span Provides 55-Foot Clearance Over Louisville and Portland Canal

Waterway Improvements at Louisville Include Unusual Type of Vertical Lift Span Raised 40 Feet by Levers on Approach Spans

EXTENSIVE improvements of the Louisville and Portland Canal at Louisville, Ky., carried on by the U. S. Government, have been in progress for several years past and are now nearing completion. They consist principally in widening the canal from 86½ ft. to 200 ft., in building a new lock 600 ft. long by 110 ft. wide alongside of the old locks and in the renewal of the two existing swing bridges crossing the canal. The new lock was described in the Engineering Record of June 26, page 794.

The old swing bridges were originally built about the year 1866, one at the head of the locks and the other at Eighteenth Street over the canal proper at Louisville. The former is being replaced by a swing bridge 275 ft. long spanning both old and new locks, the pivot pier being located between them. The Eighteenth Street swing bridge has just been replaced by a Strauss direct-lift bridge spanning the entire width of the 200-ft. canal. The old swing bridge had unequal arms, spanning 87 ft., the former width of the canal.

CONDITIONS GOVERNING DESIGN

The craft that navigate in the Ohio River at Louisville do not require more than 55 ft. vertical clearance above high-water level. On account of the low vertical clearance required, compared with the length of span, the lift type of bridge was considered best. The invitation asking designs for this structure, as issued by Major J. C. Oakes, Corps of Engineers, U. S. A., in charge of the work, contained the following clause:

"In making a comparison and selection the following are some of the points which will be considered: First cost, probable cost of maintenance and operation, advantages and disadvantages of the type of operating machinery as to the reliability of operation and chances for accidents, and provision for preventing the lift span from falling if any accident happens to parts of the operating apparatus."

First cost, therefore, was only one of a number of factors which were considered in selecting the type of lift here adopted.

GENERAL FEATURES OF DESIGN

The bridge consists of the main, or lift span, 210 ft. long, and an approach span at each end, 85 ft. and 75 ft. long respectively. The main trusses, which contain eight panels, each 26 ft. 3 in. long, are of the Pratt type with inclined upper chords, and are spaced 18 ft. apart. The approach trusses are spaced 18 ft. 6 in. apart, and the unusual offset top strut to the main column, required to allow clearance for the counterweights, can be seen in the photograph showing an end view.

The existing stone center pier of the old swing bridge has been utilized for the west pier of the lift span, and a new concrete pier, founded on rock, supports the opposite end. Photographic views reproduced herewith illustrate the finished structure. The rectangular pier showing under the center of the span is the old rest pier of the swing bridge, which, together with the old stone canal wall, will be removed when the new wall and widened part of the canal are completed.

The bridge is designed for highway traffic only. The roadway has 16-ft. clear width, the floor system and its supports being designed for a live load of 100 lb. per square foot, or one 15-ton truck on two axles 10 ft. on centers. The trusses are designed for a live load of 100 lb. per square foot of roadway. The usual unit stresses for work of this character were followed in proportioning the members. The specified permissible stresses were allowed an increase of 25 per cent during erection.

COUNTERBALANCING THE LIFT SPAN

The lift span is counterbalanced by counterweighted crane-like trusses pivotally mounted on the main vertical posts of the approach spans at either end. These counterweighted trusses are provided with a pair



OFFSET TOP STRUTS PROVIDE CLEARANCE FOR COUNTERWEIGHTS

of hangers, pin-connected near their mid-sections, while the lower extremities are pin-connected to the lift span, and their upper extremities are pin-connected to a member termed the "counterweight link," the rear extremity of which is pin-connected to the counterweight.

The concrete counterweight itself is so connected to the rear extremity of the counterweight trusses that the four main pin points form a parallelogram. By virtue of this parallelogram and the connecting hanger the main span and center of gravity of the counterweight are permitted to move vertically. The lower auxiliary fixed counterweight balances the weight of the hanger and brings the center of gravity of all the dead-load forces to the center of the main trunnions at the top of the tower post. The moments of span and counterweight about the main trunnions are ex-



CLOSED POSITION OF NEW DIRECT-LIFT SPAN 210 FEET LONG—CENTER PIER OF OLD SWING SPAN TO BE REMOVED

actly equal for any position of the bridge.

The span was erected in the partly open position to permit navigation. The half of the span over the new part of the canal was built on falsework, and the other half, over the navigable canal, was cantilevered out without the use of falsework in the existing canal. The alignment of the new bridge coincides with that of the old, but it was not necessary to maintain highway traffic during erection.

ELECTRIC OPERATION

The span travels a vertical distance of 40 ft. from the closed position to the fully open position. The movement is effected by means of electric operation, the operating pinions, four in number, being located at each corner of the span below the floor, and engaging vertical fixed racks on the inside faces of the tower posts. These pinions are actuated, through shafting and intermediate gears, by two 11' hp. direct-current motors located near the center line of the span and controlled from an operator's house, at the center of the span, suspended from the top chords above the clearance line as seen in the photographs.

One minute is required to raise the span, by electric power, from the closed to the fully open position, and the same period is required to lower it. Emergency hand operation is also provided by two turning levers which can be used at each end in the center of the roadway. Indicators are installed in the operator's house, consisting of white and red incandescent lights showing the various positions of the bridge. The movement automatically cuts out the lifting motors when the span is 6 ft. from the fully open or the fully closed position. However, a spring switch is provided which, if held closed, will render the automatic cut-out ineffectual and enable the bridge tender further to operate the bridge. Safety gates are provided on the approaches, controlled from the operator's house and interlocked with the lifting machinery so that the latter cannot be operated until the gates are closed, and the gates cannot be opened again until the bridge is closed.

The structural steel in the lift span, counterweight trusses and approaches,

weighs approximately 250 tons. The operating machinery and trunnions weigh approximately 20 tons. The steel was furnished by the Penn Bridge Company of Beaver Falls, Pa., and erected by the Middle States Construction Company of Columbus, Ohio. The Strauss Bascule Bridge Company of Chicago, consulting engineers, furnished the plans and specifications under the direction of Major J. C. Oakes, U. S. engineer at Louisville, in whose office the contract for construction was awarded in July, 1914. The bridge was completed and first operated June 23, 1915.

Rattler Test for Paving Brick Abandoned in St. Louis

Instead There Has Been Substituted a Standard Sample of One Hundred Bricks by Which Shipments Are to Be Judged

By MONT SCHUYLER

Engineer in Charge, Municipal Testing Laboratory, St. Louis

NO DOUBT the rattler test in all of its various forms has improved vastly the quality of paving brick. It is necessary that a certain strength both against disruption and abrasion should be present in every brick, and this quality, or set of qualities, is, of course, measured coarsely by any method involving rough handling, such as the rattler test undoubtedly is. But that the brick's value as a paving material can be determined with any accuracy by this method is a matter upon which more and more people have reached, first, a doubting stage, and, then, finally, a stage wherein the rattler is considered merely as a method of adjustment between the brick seller and the brick buyer. In other words, the rattler test is not an engineering instrument.

VISUAL INSPECTION IN THEORY AS WELL AS IN PRACTICE

Though, as above stated, the rattler has done much to improve the character of brick, and no doubt will in the future maintain a certain position in the paving field, still it is the writer's belief that, as time goes on, less and less attention will be paid

to the extreme refinements added during the past few years. The machine will then be used perhaps in conjunction with other machines to determine the presence or absence of certain qualities in the product of this or that factory, the actual acceptance or rejection of brick being based openly, as it is now actually, on visual inspection while brick are being handled from the kiln to the pavement.

While this thesis may be disputed in various quarters, it cannot be denied that many engineers and brick manufacturers are tending toward a gradual abandonment of the rattler. This the writer knows from many conversations with men from all parts of the country.

Following out this general tendency the city of St. Louis, in its new specifications, has omitted all reference to the rattler test, placing reliance solely upon the general knowledge of brick extant in that city's construction and testing department. The new specifications, referring to paving brick, read as follows:

PAVING BRICK

General

"Vitrified paving brick shall be made from suitable shales or inferior fire clay burnt to uniform texture throughout. They shall be thoroughly and uniformly vitrified and annealed, containing neither unfused nor glassy spots, and shall not be salt glazed. They shall be tough and uniformly hard. They shall be free from defects such as laminations, fire cracks, cooling checks, etc. They shall be free from lime or other impurities. They shall be unrepressed, side wire-cut in such a manner that the lugs will be formed during the process of cutting and shall have the ends beveled.

"At least one month before the contractor begins laying the wearing surface he shall submit one hundred (100) specimen brick of the brand he expects to use to the Board of Standardization, unless samples of brick proposed to be used are already on file. The type, the range of burning, the variation in dimensions and the general condition of the brick which the contractor expects to furnish shall be exhibited by these specimens. The president of the Board of Public Service will cull from this lot the brick



DIRECT-LIFT SPAN IN OPEN POSITION WITH CLEARANCE OF 55 FEET—SPAN LIFTED 40 FEET BY LEVERS AND PARALLEL LINKS

which are not suitable under the terms of the specification. All shipments to the work will be examined by such method as may be deemed expedient and must be equal in quality, shape and dimensions to the specimen brick which have been considered satisfactory.

Specific

"Brick shall not be less than eight (8) inches nor more than nine (9) inches in length. They shall be four (4) inches in depth and from three and one-fourth ($3\frac{1}{4}$) inches to three and three-fourths ($3\frac{3}{4}$) inches in width, excluding lugs. The brick in any one contract shall vary not more than one-eighth ($\frac{1}{8}$) inch in width or depth and not more than one-fourth ($\frac{1}{4}$) inch in length, the length desired being eight and one-half ($8\frac{1}{2}$) inches; and the brick must be the product of one plant.

"The imprint or name of the brick or maker, if used, shall be in recessed letters and not raised letters.

"All brick shall have one wearing surface such that when the brick is laid on a horizontal plane on this surface, no portion of this surface shall be more than three-thirty-seconds ($3/32$) of an inch from the plane.

"The lugs shall be of such dimensions that when the brick are laid in the street there will be an average separation of courses of not less than one-eighth ($\frac{1}{8}$) inch nor more than one-fourth ($\frac{1}{4}$) inch.

"The president of the Board of Public Service may inspect or sample the brick either at the kiln or on the street, or at both places. All brick shall be subject to thorough inspection before and after laying and rolling."

Already the sample brick are being delivered in accordance with the specifications and the process of carrying out the culling of the samples will be shortly completed.

APPLYING THE STANDARD SET BY SAMPLE

Let us see what a tendency of this method of specifying paving bricks is. Assume that bricks have been delivered to the street. Undoubtedly the city's cullers will reject some particular type of brick, but their rejection will not be based upon the insensible training which they have acquired during many years of the same sort of work, but upon the standard sample which covers the entire range of bricks which the manufacturers can deliver and which the city is willing to accept. This standard sample has carried them back to streets which have been in service, for the culling of the standard sample has been predicated upon experience with brick in the street. That is to say, in examining the standard sample a brick is not thrown out if actual observation has shown that a specimen of the same characteristics has worn satisfactorily in the streets for a number of years.

Now let us make the assumption that a certain type of brick has been adjudged unsatisfactory by the city's representatives. The brickmakers have retained a duplicate of the standard sample and have, in addition, of course, the official sample to refer to; and, if in their opinion the rejected brick are duplicates of those in the standard sample, it becomes a very easy matter to make a comparison and to be sustained if the comparison shows substantial similarity.

It is, of course, assumed that there ex-

ists a certain knowledge of paving brick characteristics. The use of brick as a paving material has become so general in the past ten years that there is hardly a city of any size which has not one or more streets paved with brick. Most municipalities, in fact, have gone to the extent of purchasing rattlers, and it is felt that if a city has talent enough in its employ to properly run a rattler in accordance with

the methods laid down by the American Society for Testing Materials, it must be able to "size up" and adjudge a standard sample of 100 brick. In any case, however, in those places where culling is conscientiously carried out, the method adopted by the city of St. Louis will add no new difficulties, but, while abandoning a laborious test, will eradicate any chance of dispute between buyer and seller.

Newark Is Rapidly Creating Its Own Water Terminal in New Jersey Meadows

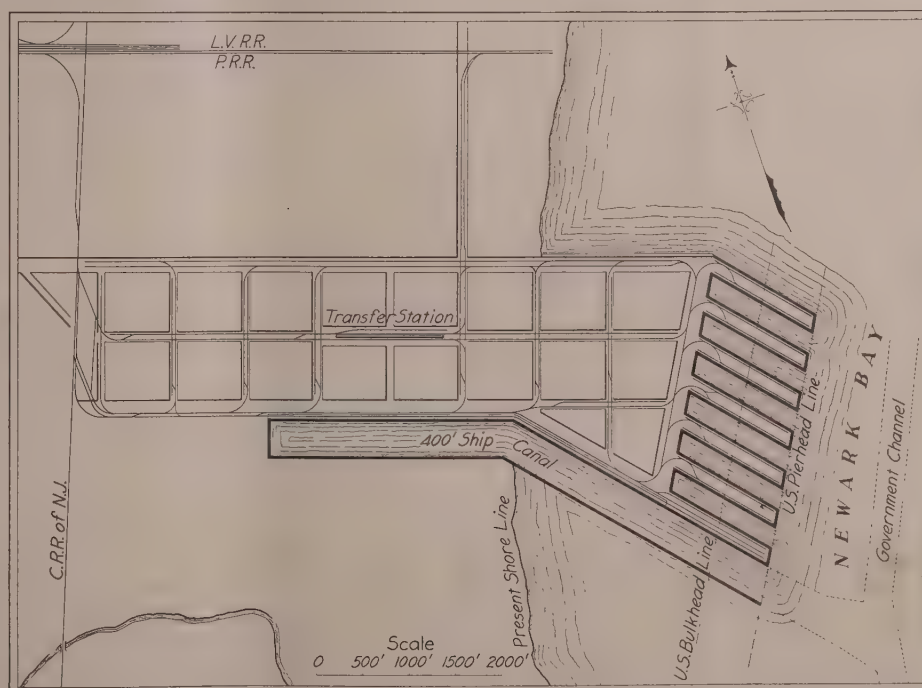
By Reclaiming 260 Acres and Providing Wharfage and Rail Connections
New Jersey Metropolis Aims to Attract Shipping and Industries

AN EXPRESSION of the growing determination of the New Jersey communities opposite New York City not to sit idly by and allow New York, by offering superior port development, to absorb the bulk of the enormous water traffic coming to New York harbor is seen in the extensive development that has been quietly under way in the southern part of Newark for the last year. Under the direction of the Board of Public Works of that city, 260 acres of meadow land bordering Newark Bay are being reclaimed and converted into a modern water terminal. The new seaport will be reached by a 20-ft. government channel, and connections with three railroads are expected to make the site an attractive one for factories. The engineering features include a large amount of hydraulic fill, the use of both concrete and timber bulkhead walls, and the construction of a heavy creosoted timber dock carrying railroad and crane tracks. The work now under way is part of a larger project to cost from \$12,000,000 to \$15,000,000.

The site of the improvement is at Peddie Creek and Newark Bay, 4 miles from the Newark city hall. The Newark-Elizabeth line of the Central Railroad of New Jersey parallels the bay a mile inland. Half a mile north of the development the Lehigh

Valley Railroad and the Greenville freight branch of the Pennsylvania Railroad cross the bay. The present development is confined to the tract north of Peddie Creek. As shown on the accompanying map, a strip of meadow 1700 ft. wide, at an average elevation of 5 ft. above mean low water, extending outward from the Central Railroad of New Jersey to the shore line, is being filled to an elevation of 11 ft., and this fill is being carried on out into the bay about 1600 ft. farther to the city bulkhead line, which is moved back 600 ft. from the government line to make possible the construction of 1200-ft. piers. On the south side a 400-ft. ship channel will extend inland 2500 ft. from the present short line.

Along the ship channel is being constructed a heavy timber dock 50 ft. wide, carrying two railroad tracks. Behind the dock the fill will be held, as far as the present shore line, by a concrete wall on a timber substructure below low water. Beyond the present shore line the concrete wall is replaced by a creosoted timber bulkhead, which passes on around the east and north sides of the fill to the present shore line. At the outer end of the development one of the seven piers contemplated is to be built at the present time. South of Peddie Creek and the ship channel an equal area



TRACKAGE ARRANGEMENT AND TRANSFER STATION FOR THE SEVEN 1200-FT. PIERS
OF NEWARK'S PORT DEVELOPMENT



THROUGH A PIPE LINE ON PONTOONS DREDGED MATERIAL FOR THE HYDRAULIC FILL WAS PUMPED A DISTANCE OF 5700 FT.

is ultimately to be developed in a similar manner.

Typical details are shown of the bulkheads and the timber dock. Along the outer side of the dock a traveling crane will run on a track of standard gage. For about one-quarter of its length the dock will be elevated 4 ft. 2 in. to permit direct loading into cars on the track in its center. A ramp at each end on a 2 per cent grade will lead to the elevated part of the platform. All tracks are being laid with 100-lb. rail.

In making the hydraulic fill it was necessary to pump the material the greatest distance at the start, when the dredge was obliged to work from the government channel in the bay, 3500 ft. from shore. The 27-in. pipe line was on pontoons to the shore line, and thence on a light timber trestle built up the middle of the improvement. Material was thus pumped as far as 5700 ft. As the dredge worked its way into the central channel of the improvement the pipe line was shortened, and at present any section of the fill is used with a short line.

The pipe line is generally laid with a "Y" near the outlet, with valves at the "Y," and as one branch is being extended or moved the other takes the flow of material. This material varies greatly, from soft mud when the dredge is working near the surface to heavy red clay when the maximum depth is used. In general, however, the material is light enough to spread readily over the settling areas, and no great amount of pipe shifting is required.

Beyond the present shore line the bay was soft mud for a depth of some 20 ft. Before the bulkhead piles were driven this mud was dredged away in a channel 70 ft. wide at the bottom, and the channel was refilled with a substantial material, into

which the bulkhead piling was driven. This method was considered more satisfactory than placing the material around the piles.

The edge of the meadows is nearly a mile inshore from the line of the Central Railroad of New Jersey. Preliminary to starting the improvement proper, therefore, it was necessary to grade an approach thereto,

and this in reality constituted about the most difficult part of the filling, because of the necessity for working outward from the end of the fill, and because of the numerous sink holes encountered, making it necessary in places to use a crude timber cribbing. This approach fill was made of household refuse and ashes, and the first work on the improvement was the construction of a trestle at the inner end of the approach. The refuse wagons drove on the trestle and dumped into cars on the construction track, which now reaches to the Central Railroad of New Jersey.

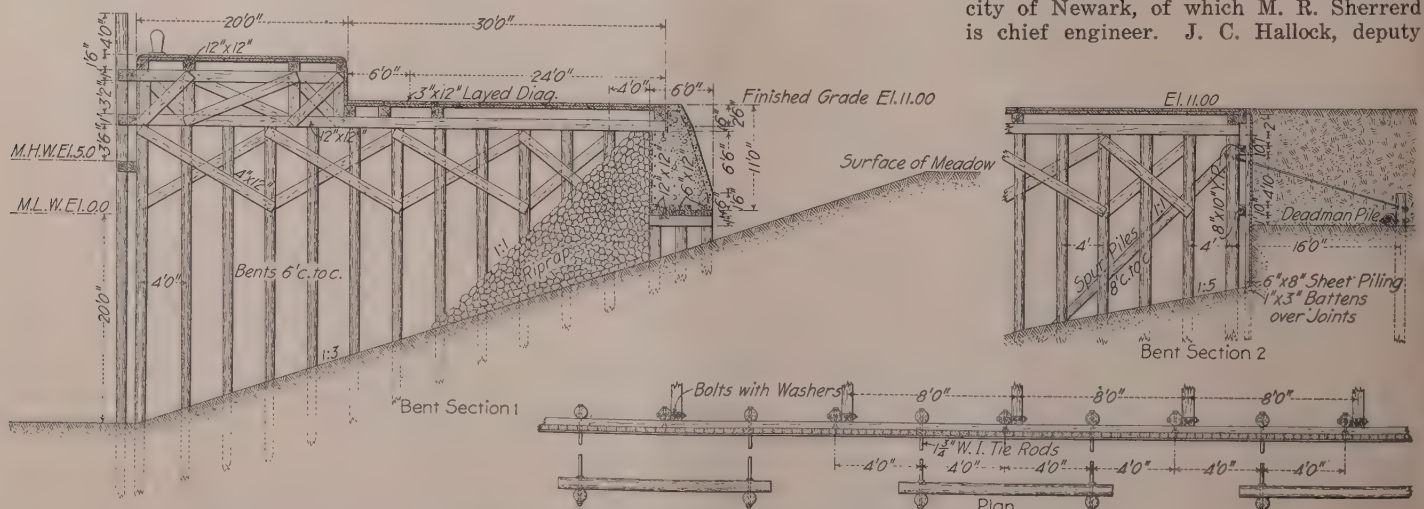
While the details of the trackage to be provided on the improvement have not been worked out, the main features will be substantially as shown. A main classification yard will be built alongside the Central Railroad of New Jersey, and at about the center of the tract will be a smaller transfer yard. The connection shown to the Pennsylvania and Lehigh Valley railroads has already been built.

Only a few of the principal streets will be paved at the present time. Before the tract can be properly accessible for industrial purposes it will be necessary for the street railway company to build a line down the Bay Avenue approach. It is not desired, however, to lay extra tracks in the streets of the terminal to accommodate electric cars, nor to permit trolley wires over the tracks to be used by steam equipment; therefore storage-battery cars only are to be operated east of the Jersey Central, these cars to use the steam road tracks. Bay Avenue is to be carried over the Jersey Central by a bridge.

The improvement, on which \$1,500,000 of the preliminary appropriation of \$2,250,000 has already been spent, is being carried out by the Department of Public Works of the city of Newark, of which M. R. Sherrerd is chief engineer. J. C. Hallock, deputy



DRIVING INCLINED SPUR PILES



TYPICAL DETAILS OF BULKHEADS AND TIMBER DOCK FOR NEWARK'S \$15,000,000 WATER TERMINAL



TIE RODS FROM DEADMAN PILES WILL AID IN RETAINING FILL

chief engineer, is in direct charge of the work, and A. J. Simpson is the assistant engineer on the ground. The contractors are the Atlantic, Gulf & Pacific Company on the dredging and hydraulic fill, and O'Gara & McGuire on the dock construction.

Overcrossing Has Provision for Future Sidewalks

New York Central Reinforced-Concrete Viaduct Near Batavia Contains Embedded Rods with Threaded Ends for Future Brackets

A RATHER unusual detail was adopted by the engineers of the New York Central Railroad to provide for future sidewalks on the new reinforced-concrete viaduct approaches of the East Main Street overcrossing east of Batavia, N. Y. A 24-ft. clear roadway is furnished, as shown, and provision is made for the future addition of a 5-ft. clear sidewalk on one side. On the steel truss spans this sidewalk is provided for by the design of the east trusses for brackets to be added later. In order to support the future sidewalks at the piers of the approaches the method shown by the accompanying drawing was adopted.

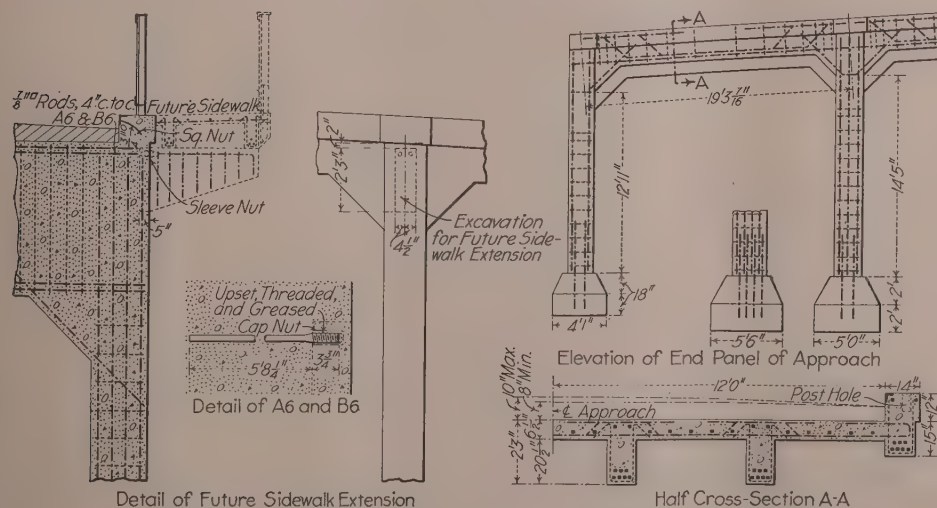
A 5-in. excavation 9 x 27 in. in size is to be made for the new brackets in the concrete of the piers when the sidewalk is added. The tension connections for these brackets is provided by the two $\frac{7}{8}$ -in. square rods shown, to which sleeve nuts will connect the new reinforcing steel in

the brackets. A temporary cap nut protects the screw thread at the end while embedded in the concrete.

The bridge consists of three truss spans and reinforced-concrete viaduct approaches at each end on 6-per cent grades. The steel triangular truss spans are supported on square columns with skewed protection walls from 11 to 12 ft. high. These spans are approximately 126 ft., 76 ft. and 50 ft. long. The two approaches are 96 ft. and 98 ft. long, each consisting of five panels 19½ ft. in length. The accompanying detail drawing of an end panel of one of the approaches indicates the method of reinforcing. Following the usual practice of this railroad, all reinforcing rods are given shipping marks and separately detailed.

The crossing was designed under the supervision of J. W. Pfau, engineer of construction; N. F. Thompson, engineer of grade crossings, and H. T. Welty, engineer of structures, of the New York Central Railroad. John M. Holler of Albany was the general contractor.

NUMBERING COUNTRY ROADS is proposed for Iowa highways in the June issue of the Service Bulletin of the State Highway Commission. It is proposed to use the Capitol building at Des Moines as a center from which to number the roads in the four quadrants. Another suggested scheme is to label every road at intersections by its local name. Both schemes carry the proposition of numbering all farm houses.



PROVISION FOR FUTURE SIDEWALK MADE IN DESIGN OF OVERHEAD CROSSING

Railroad Subgrade Troubles—Preventives and Cures

Importance of Drainage Emphasized—Suggestions for Second-Track Construction—Remedies for Settling and Sliding Fills

By J. T. BOWSER

Maintenance of Way Department, Queen & Crescent Route, Danville, Ky.

ALL RAILROADS, it may be said, except those traversing very dry country and those where the material in the subgrade is exceptionally good, experience more or less trouble from slides, settling fills and soft places, due to a great extent to improper construction methods, or failure to anticipate conditions which could have been foreseen had the proper investigation been made prior to construction. A strict adherence to the average specifications for grading, and a careful investigation of foundation, fill material and drainage, will prevent the greater part of such difficulties, and, where such conditions exist already they can be corrected in many cases by simple and comparatively inexpensive means.

It is no doubt true that with practically no exceptions all such conditions are due to the presence of water in unnecessary quantities in the subgrade. In many cases this is due to improper construction methods, such as refilling through cuts where excavation has, through error or design, been carried below grade. Only the best of material should be used for such purposes, and when the backfill is only a matter of a foot or so, it is probably more economical to raise the track up to grade on ballast.

On second-track work a careful inspection of the old grade should always be made to detect the presence of old slides which may have ceased to give trouble, and of seeps and wet-weather springs. Provision should be made to drain or otherwise insure that the old slides will not slip again under the weight of the new fill, or that the seeps and springs will not soften or render unstable the foundation under the fill or the material in the fill itself.

Where it is possible to do so the culverts under fills should always be located at the lowest point under the fill, and where this is not practicable provision should be made to drain the low point. Where the slope assumed by the material in the fill is greater than was estimated and the culvert is found to be too short, the necessary extension should be made immediately in order to prevent the blocking of the culvert and the possible saturation of that part of the fill beyond the end of the culvert.

A poor foundation for the fill cannot always be improved, but in many cases the condition can be remedied by the interception of seepage or by other provision for drainage of the water which renders it unstable. Such seepage can be intercepted by French drains, tile or even open ditches parallel to the track and up slope from it, and drainage of the foundation can be effected by transverse French drains or tile ditches. In some cases where none of these are practicable, the character of the strata underlying the bad material may often permit drainage by dynamiting, that is, by drilling a large number of large holes well into rock or hardpan, and opening up fissures in this material by the explosion of heavy charges of dynamite in these drill holes. The expense of work of this nature will probably be slight when compared with

the expense of maintaining track on a settling or sliding fill, or of draining it after the fill has been made and the settlement started.

Drainage ditches parallel to grade are often blocked in making fills, and provision should always be made to dispose of the water from even the smallest of them.

In farming countries the impounding of water against embankments for use of stock or other purposes, has often been done as a consideration for the acquisition of right-of-way or for other privileges. Even under the best of conditions the economy thus effected is likely to be false, and it is more than probable that many times the amount saved will be spent in maintaining such an embankment when it has become saturated with water thus impounded.

The usual specifications for grading also provide for the drainage of borrow pits, but many sliding or settling embankments owe their condition to the lack of enforcement of this clause. It is not always sufficient to see that an opening is made from the borrow pit, but the entire pit should drain to this opening. The small amount seeping from a low place in the pit during the rainy season may be quite enough to start the settlement of an adjacent fill.

Further provision is usually made in specifications for grading for the proper bonding of the new fill to the old, but the effectiveness of this bond is often destroyed by having a low place in the top of the new grade near the junction with the old embankment, even though such a low place be comparatively small. Such a place would in all probability be filled with ballast or other porous material, and would become a small reservoir to supply the seepage to start the new fill sliding on the face of the old.

Old embankments are often widened with light friable material, cinders and the like, and heavier and less permeable material placed on this in making the grade for an additional track becomes a dike to hold, in the light material, the water which may fall on it at the surface, or seep into it from other sources. In some classes of material this will finally result in the settlement of both the new and the old embankments.

In many cases where sliding or settling fills, or soft places in subgrade, already exist, they can be remedied by a relatively small expenditure, that is, small when compared with the expense of maintenance under the existing conditions. In considering the best means of remedying such conditions, there may be some few instances where the use of piling or retaining walls is not only effective but is also the most economical and practicable expedient, but it may be said that such cases are comparatively few, that the use of piling does not give permanent relief and that the construction of expensive retaining walls is not justifiable when other methods are considered. Neither of these gets at the cause of the trouble, neither provides for better drainage.

For the settling fill of small or medium height, when the trouble appears to be from within, transverse drains, cut from the toe to a point back in the fill well under the track, and tiled or backfilled with stone or porous material, will often provide the necessary drainage and stop the settlement. Tile will not answer in all cases, as it is likely to get out of line or surface, while stone backfill not only provides the necessary drainage but adds to the stability of

the fill. Of course the trouble may be from without, in which case the above style of drainage is unnecessary. A pocket on the slope, caused by unequal settlement or some other cause, may be supplying the water which is causing the settlement.

While settlement of embankments is usually caused by conditions within, sliding is usually caused by conditions without or underneath. The interception of seepage, the drainage of old borrow pits ditching or tiling on the uphill side, as outlined above

in connection with construction questions, are also applicable as remedies for existing slides according to conditions. This is also true of drainage by blasting, although in this case a careful study should be made to locate the holes correctly and to get them well down into the material to be fissured to provide drainage. Such blasting is most effective when the holes are drilled by a well drill and are shot heavily. The holes should be located in a row parallel to the track, and rarely more than 30 ft. apart.

\$16,000,000 Required for Los Angeles County Flood Protection—Part I

System Recommended Eliminates Reservoirs but Includes Retarding Dams, Underground Storage, Levee Work and Stream Diversion

RECOMMENDATIONS for a comprehensive project for control of floods in Los Angeles County are contained in a series of reports presented to the Board of Supervisors on July 27, by the Board

\$12,824,400, and for rights-of-way, \$3,384,500, making a total cost of \$16,208,900. The loss which occurred in the flood of 1914 was over \$10,000,000 and investigations extending back over a period of many years, says the general report of the board, show that destructive floods will occur at average intervals of less than five years, and these conditions, with the rapidly increasing cost of right-of-way, indicate the public necessity of promptly carrying out measures for relief.

The engineers, in their studies, have had to deal with the physical characteristics of an area which includes precipitous mountains, detrital valleys and coastal plains with rivers subject to enormous winter flood discharges, through channels whose gradients rapidly change, and whose courses gyrate through wide stretches of the most highly improved agricultural and horticultural districts in the United States. The engineering problems involved include flood prevention, flood protection and harbor preservation, with the only existing precedents in Europe, India and Japan, and none in this country.

CHARACTER OF TOPOGRAPHY

The Southern California streams debouch from mountain canyons upon detrital cones, extending over gravel-filled valleys. Because of the detrital deposits, the streams raise themselves above the surrounding country, so the report states, and in floods break their banks and make for themselves new channels. The mean annual rainfall on the coast is about 14 in., increasing in intensity with elevation, as the crest of the Coast Range is approached. Storms create violent, erratic, and usually quickly passing floods. Plans for flood control must recognize that history shows that floods 70 per cent greater than the disastrous one of 1914 have occurred, and must be provided for in the future. The board enumerates methods of flood control used elsewhere—forestation, impeding reservoirs, storage reservoirs, channel rectification and levees. The problem here is to utilize all the above methods with the addition in this locality of "spreading." This general report outlines briefly flood control plans by districts, designated respectively as the Mountain District, San Fernando District, San Gabriel District, and Coastal Plain District.

The mountain district has an area of 750 sq. miles with twenty-five main drainage lines. The discharge has reached 45,000 cu. ft. per second from its largest



ONE OF SEVERAL PLANS FOR DIVERTING LOS ANGELES RIVER TO ALAMITOS BAY

of Engineers, Flood Control, appointed in April, 1914, signed by four members, H. Hawgood, chairman, Capt. Charles T. Leeds, J. B. Lippincott and Frank H. Olmsted, secretary. The fifth member of the board, James W. Reagan, filed a dissenting report. Supervisor F. H. Woodley, director of public works, Los Angeles County, has been in touch with the Board throughout its investigations. The report is in five parts, a main section and four additional sections, each devoted to some special phase of the subject. These phases were assigned to individual members of the board. Among the measures recommended are retarding works and ground storage in the higher reaches, levee construction and stream diversion.

COST

Estimates accompanying the reports indicate that the cost of carrying out the projects suggested would be, for structures,

individual catchment area, the San Gabriel, 222 sq. miles in area. Larger streams slope from 200 to 300 ft. per mile, the smaller ones from 700 to 1400 ft. In the February, 1914, storm the crest discharge rates ranged from 120 cu. ft. per second per square mile from the San Gabriel area to as high as five times that from smaller drainage areas.

RETARDING WORKS

Retarding works should be as successful here as in Europe, as the mountain formation here is largely granitic, compared with the foreign sedimentary rocks, so the relative amounts of detritus carried out should be less here than there. The precipitation here is less in total amount, but probably the rate of rainfall is much higher. The opportunity here for "rebrushing" is less

The most vital element in the control of the rivers passing through the coastal plain to the sea, is the protection of Los Angeles Harbor from silt discharges, and the report recommends, as the only safe and adequate protection of the harbor, the complete diversion of the rivers to Alamitos Bay to be accomplished at some point above the vicinity of Dominguez through the construction of diversion dikes. The co-operation of the Government will be required to put this plan into effect. Incidentally, the Forest Service has indicated its desire to co-operate in forest protection.

In the lowlands, no way to obviate the necessity for levee construction exists. It is found necessary to handle the waters of the lower San Gabriel River in two separate channels. The portion from the main drainage basin of the San Gabriel proper,

and by conservation work in the upper tributaries.

RUNOFF

The rivers discharging into San Pedro Bay and Alamitos Bay have a mountain catchment area of 615 sq. miles. The average elevation of this mountain district is 3680 ft., and the average annual precipitation is between 20 and 30 in. The rainfall over this mountain area, during the four-day flood period of February, 1914, averaged 14 in. Accumulation of silt, sand, gravel, and boulders at critical locations created points of extreme danger. Diminution of this peak flood flow now demands controlling structures above the canyon mouths.

In the 1914 flood a single hour showed a 1.49-in. rainfall, 21 per cent of and seventeen times its proper proportion of the four-day storm. This heavy fall occurred after 13 hours of rain. The report gives a tabulation of the high water marks in all the canyons.

The opportunity for storing flood flow in large reservoirs in Los Angeles County does not exist. Protective work in the lower channels alone would not be effective due to conditions arising from the presence of detritus, while spreading of flood flows on the gravel cones below the canyon mouths promises only limited relief. Adequate control requires an attack on the floods at their sources in the high mountains, and utilization to the greatest extent practicable of surface storage, flood spreading, and channel rectification and control.

RETARDING DAMS

Experimental work in Haines Canyon and on Clear Creek, shows the applicability of the European system of retarding dams to the county's needs. Haines Canyon, in the 1914 storm, showed a run-off of 712 cu. ft. per second per square mile, which was normal considering its small area, its lately burned-over slopes, and its badly eroded washes. Haines Canyon has a total watershed area of 6.50 sq. miles, with 3.90 sq. miles of this area above the valley. The sides of the canyon have been entirely denuded of brush and timber by fire. Under Mr. Olmsted's supervision, there have been constructed in Haines Canyon 384 small checks for retarding the velocities of the stream flow, the cost of each structure running from \$5 up to, in one case, \$500. The total construction cost amounted to \$4,650.50 for the dams, and \$1,350 for trails, administration, etc. The average expenditure directly for the dams was \$12.11 each, and for the dams with the collateral trail construction and administration, \$15.62 each. The foreman in charge of construction was Clarence S. Buck, who previously had built many structures of a similar kind in Alaska.

Four small dams finished in Western Empire Canyon, a tributary of Haines Canyon, prior to the 1914-15 floods, which in this 22-acre watershed probably showed a precipitation for the full storm of Jan. 23 to 30 of 9.85 in., with 1 in. of rain in the lower section in a single hour and a half, showed that the check dams so retarded the flood water that no flow whatever reached the main drainage line of Haines Canyon, and now, July, 1915, the bed of the stream is being rapidly grown up with willows and brush where previously nothing ever grew.

The movement of small volumes of water



EXPERIMENTS ARE BEING MADE WITH THESE SMALL IMPEDING DAMS

on account of the long summer season, and protection against fire and waste of every kind is less. Water conserved by retarding devices would have greater economic value here than there.

In recommending spreading and assisting water to percolate underground at the mouths of certain canyons, it is mentioned that the experience in spreading waters in San Bernardino Valley shows they may be put underground at a cost of approximately 14 cents per acre-foot for operating and interest charges. The treatment of the coastal plains district must recognize the conditions arising from construction of storm drains by the city of Los Angeles, which will deliver an ever increasing percentage of the runoff in a manner conducing to sharp flood peaks. Construction of impeding dams in the canyons will tend to desynchronize peaks from these sources.

In the summary the report points out that restoration and preservation of brush would enhance summer water supply, check winter floods and lessen production and discharge of debris onto the plain. The conservation of winter storm waters on debris cones is heartily endorsed. Water may be stored underground by surface spreading at a cost of less than 5 per cent of its value for irrigation purposes, but spreading cannot eliminate great floods, because flows are too great and swift, and because the turbid nature of the water retards infiltration. Spreading will take care of lesser flows succeeding the peaks.

as well as from its eastern tributaries, should be carried in the Eastern Channel through Paso de Bartolo to a point of confluence with the diverted Los Angeles River east of Bouton Lake. Water from the district between Arroyo Seco and the San Gabriel naturally collects into the western flood channel known as the Rio Hondo. It should be permitted to continue in this course, joining near the County Farm the waters of the lower Los Angeles River between the city and the harbor.

Mr. Olmsted on Conservation

Mr. Olmsted's specific assignment, in dividing the work of the board, was the study of absorption of gravels and the spreading of floods.

Mr. Olmsted mentions factors which will make future damage exceed that of preceding years, unless a wise policy of control is energetically pursued from this time on: The unchecked erosion from fire-swept mountain areas, the removing of original brush protection on the foothills in the natural course of settlement and growth, the present deplorable stream-channel conditions, and the relatively greater value of lands and improvements. The large initial outlay for flood control by storing and retarding the waters is justified on the ground of conservation and permanent control. While Los Angeles County conditions imperatively demand flood channels, the permanency of the lower flood channels can be insured by eliminating the silt and debris,

down this canyon, having a slope of 13 deg., was about one foot per second. The average retarding effect of the $6\frac{1}{2}$ ft. dams, as determined by potassium permanganate was 0.2 ft. per second. A heavy flood will have a surface velocity equal to a 5.2-per cent grade, instead of that due to a slope of 23-per cent grade. Assuming that the class of construction utilized in Haines Canyon is permanent, the results there have demonstrated that the excessive flood peaks for this particular tributary are subdued, and only minor flood flows are to be provided against in the lower channels.

The report reviews briefly some of the important work done abroad with retarding dams. The greatest erosive action of the water is not when the flow is largest. The moment the velocity commences to decline, the largest and heaviest boulders are dropped and the still comparatively rapid current, forced to follow a serpentine course is deflected against the easily eroded banks. The stream will then continue to take in suspension additional load until an entirely new regimen is acquired. This regimen is dominated, first, by the relative depth of the water; second, by the width of the channel, and last, by the grade. The widening of the stream by an increased separation of the banks at once lessens the depth and diminishes the velocity, with resultant deposits of suspended matter.

EXPERIMENTS

Experiments are being made at a station in Clear Creek to furnish definite data for determining (1) the action of a large flood crest in a small canyon as nature left it; (2) the parallel action of the same flood crest when the channel has been cleared of obstruction; (3) the action when definite breaks and check dams obstruct the channel; (4) the class of dam that will withstand the flow. The equipment of the station consists of a dam, gaging stations and signal devices. The dam is of the rock-fill type, the fill having a slope of 2 to 1, while the up-stream face is a masonry wall approximately 30 in. thick. The dam is 24 ft. high, will hold about 124,000 cu. ft. of water, and is equipped with a collapsible wooden gate 5 ft. wide by 7 ft. high, located at the lowest point in the face of the dam, and so constructed in sections that it gives an instantaneous opening of this size. The general scheme is to allow the water to rise to a given depth and then suddenly release it, creating artificial flood conditions in the channel below. The receding crest of this extreme flood wave in its successive crossings of the various gaging stations is then noted.

RESULTS

In experiment 1, July 6, the reservoir contained 15,000 cu. ft. of water, standing 9 ft. deep at the gate. It took the crest water 2 hr. 50 min. to travel 7300 ft. from the dam to the mouth of the canyon. Calculations show that with the type of channel the water should have reached the mouth in 9 min. 21 sec., provided water is being continually supplied in sufficient quantity to maintain the above hydraulic radius at all points in the channel during the passage. The flattening of the crest and decrease in velocity may be due to one of three, or all of three, causes: channel obstruction, decrease in water supply, and flattening of the slope. Hence, all reduction of velocity in the experiment cannot be credited to the obstruction factor, and due

weight must be given to the decreasing hydraulic radius, and to increase or decrease of slope.

The natural obstruction at present in the channel is large and its value an unknown quantity. Its removal and the substitution of check dams and cross breaks would permit application of hydraulic formulæ in seeking for the cause of reduction of crest and retardation of velocity. A second experiment with part of the channel cleared gave a velocity of 6.8 ft. per second, attributed to a larger volume of water in storage, which increased the hydraulic radius of all sections. Data obtained are considered inconclusive. Conclusive data require experiments on a channel fully cleared for 1500 ft., and then, after finishing a full series of experiments on a clear channel, a second series after installing a complete system of check dams.

An appropriation of \$100,000 is advised for rebrushing denuded slopes.

ENFORCED PERCOLATION

The balance of Mr. Olmsted's report is devoted to an itemized consideration of conditions in individual canyons, and a detailed estimate of works for minimizing flood crests in the form of check dams and brush breaks. The improvement of the important Verdugo Channel, for the protection of the property in Glendale and for causing waters diverted into the gravel to replenish underground storage for pumping purposes, is proposed through the construction of an improved channel. This will effect the desired purposes by bank protection and by reducing the grade of the stream to 0.4 per cent by means of falls or weirs built in the channel, similar to the Indian diversion weirs, the basic theory of which is, that the length of the base or impervious floor of the weir, that is, the length of enforced under percolation, is a function of the height of the structure and of the character of the material on which it is built, or $l = CH$ in which l is the length of floor, H the height of weir above normal stream channel, and C a co-efficient depending upon the character of the material of the stream bed.

For stream-bank protection a 4-in. reinforced concrete slab on a 1 to 1 slope is proposed.

Control of the San Gabriel is proposed by effecting varying retardations of the peaks in its several tributaries, so that the peak in the main channel will not be the accumulated product of synchronous run-offs. Detailed studies for each tributary are presented. The estimates for the work proposed in Mr. Olmsted's report amount to a total of \$4,130,838, divided as follows: Impeding dams, etc., \$1,410,400; masonry dams, \$450,000; rock fill dams, \$154,726; spreading, \$2,015,712; forestry, \$100,000. This estimate covers the improvement of all the watersheds in Los Angeles County. Definite plans for the individual structures in so wide a range of territory will vary according to the conditions encountered, and will be affected by the results obtained from the Haines Canyon work and the Clear Creek experimental station.

To be Continued.

The second part of this article will contain abstracts of the reports of Messrs. Haugood, Leeds and Lippincott, dealing respectively with flood control in the San Gabriel district, in the coastal plain and in the San Fernando Valley.

Omit Transverse Joints in Brick Pavements

U. S. Office of Public Roads States That Longitudinal Joints Are Sufficient and Specifies Their Proper Width

IT has been customary in the past to provide both longitudinal and transverse bituminous expansion cushions in grout-filled brick pavements, but recent practice has demonstrated that the transverse cushions may be advantageously omitted if proper longitudinal cushions are provided. This is the opinion expressed by Vernon M. Peirce and C. H. Moorefield of the office of Public Roads, in Bulletin 246 of the U. S. Department of Agriculture. The principal objection to the use of transverse expansion cushions is based on the fact that the material composing the cushions frequently softens during warm weather and runs out toward the curb, thus leaving the edges of the adjoining brick exposed to destructive impact from the wheels of passing vehicles. Even if the cushion consists of a material which does not run in warm weather, it is necessarily softer than the brick, and the natural result is still the development of unevenness in its immediate vicinity. No such objection can exist concerning longitudinal expansion cushions, however, if they are placed adjacent to the curbs and constructed of proper material. They not only furnish a means for the pavement to expand and contract with changes in temperature, but they also eliminate to a large extent the disagreeable rumbling which has been so frequently associated with grout-filled brick pavements. The bituminous material of which the expansion cushions are made should be such as to remain firm in summer and not to become brittle in winter. It should also possess the quality of durability.

EXPANSION CUSHION THICKNESS

Expansion cushions should be provided for at the time the brick are laid by placing a board of the required thickness on edge adjacent to each curb. Small iron wedges may be inserted between the curb and the board at the time the board is set. These wedges may be readily loosened and removed after the bricks have been laid and grouted, and may consequently be made to facilitate the removal of the board.

The proper thickness for expansion cushions is a matter concerning which much difference of opinion exists among highway engineers. Some engineers advocate a minimum thickness of 1 in., while others claim to have secured their best results by using expansion cushions having a minimum thickness as low as $\frac{3}{8}$ in. for very narrow pavements. It is generally agreed that the thickness of the cushion should vary with the width of the pavement. The following suggestions for proportioning the cushion are offered as being fairly representative of the best practice:

For a 20-ft. roadway the cushion thickness should be $\frac{1}{2}$; for 20 to 30-ft. widths, $\frac{3}{4}$ in.; for 30 to 40-ft. widths, 1 in., and for widths over 40 ft., $1\frac{1}{4}$ in.

THE ULTIMATE DEVELOPMENT of the highways of Colorado will include about 16,000 miles of State road, or more than 50 per cent of the total mileage in the State. The maintenance on these roads, according to the State Highway Commission, will cost about \$640,000 a year—an average of \$40 per mile per year.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[Contributions to this section are solicited, and if found available will be paid for. They must be SHORT, and should be accompanied, if possible, by photographs or sketches.—EDITOR.]

Concrete Material Tables Have Saved Money on Road Work

TO give the men in charge of distributing concrete paving materials an idea of how much material to send a given section and how much to unload at a given spot, the accompanying tables have been employed by the road commissioners of Wayne County, Mich. They have proved a

The suspension bridge with timber towers is probably the least expensive type. The one shown crosses Broadway and Seventh Avenue at Forty-second Street, and was built by the Rapid Transit Subway Construction Company. The truss bridge shown was built because a necessary bend in the pipe line made a suspension bridge impossible. It crosses Broadway below Thirty-fourth Street. The third type, a suspension bridge with simple steel towers, the towers and cable anchorage being set in a single concrete block, saved some sidewalk space. The bridge shown is across Broadway at Thirty-second Street. Both of the bridges at Thirty-fourth Street and



SUSPENSION BRIDGE WITH STEEL TOWERS

Thirty-second Street were built by the United States Realty & Improvement Company.

Width of Road	Cu. Yd.	Pebbles Tons	Carloads	Cu. Yd.	Sand Tons	Carloads	Bbl.	Cement Tons	Carloads
12 ft.	1369	1916	55	684	855	20	2396	455	13
15 ft.	1711	2395	69	855	1069	24	2995	569	16
16 ft.	1825	2555	73	912	1140	26	3194	607	17
18 ft.	2053	2874	82	1026	1383	31	3594	682	20

1 cu. yd. pebbles, 1.4 tons; 1 carload pebbles, 35 tons; 1 cu. yd. sand, 1.25 tons; 1 carload sand, 44 tons; 1 cu. yd. cement, 0.19 tons; 1 carload cement, 36 tons.

TABLE GIVEN TO MAN ON THE GRADE—AMOUNTS TO BE PLACED PER 100 FT. STATION

Width of Road	Bbl. Cement	Yards Gravel	Sand	Wagon Loads Cement	Gravel	Sand
12 ft.	45	26	13	4	20	10
15 ft.	56	33	16	5	25	12
16 ft.	60	36	17	6	27	13
18 ft.	68	39	20	6	29	15

Cement—45 sacks to 1 load; gravel—1½ yd. to 1 load; sand—1½ yd. to 1 load.

great success in reducing to a minimum the rehandling of materials, caused by accumulating too much at one point.

Three Types of Bridge for Carrying Gas Mains Across Subway Cuts

THE ACCOMPANYING photographs show three types of bridge developed for carrying gas mains across street intersections in New York City while subway construction is going on. These mains have to be laid temporarily above the street surface, as an accident to them in the course of construction for the new subways might prove very serious.



LIGHT TRUSS BRIDGE FOR GAS MAIN



SUSPENSION BRIDGE WITH TIMBER TOWERS GUYED TO CONCRETE ANCHORAGE

Proper Distribution of Castings Saves Money on Pipe Contracts

AN intelligent distribution of pipes, special castings and appurtenances will lower the water main contractor's costs considerably and will turn into profits what would otherwise be sheer waste. This is especially true in the case of work done in large cities.

A definite program of the procedure should be decided upon well in advance of opening the ground. Then the proper pipes, special castings, valves and hydrants should be ordered shipped to the nearest railroad station or dock for each particular section. This should not be done too far in advance of actual operations. Materials of this kind laid out on the streets mean either the expense of watchmen and lamps or the risk of police violations or accident liability.

Pipes should be distributed uniformly along the line of work. They should not be laid down in bunches, with a shortage all along the way and a cluster every hundred feet or so. Pipe rolling costs money. Even the most inexperienced know that a pipe that lays 12 ft. in the trench, with the spigot shoved back home into the hub, will occupy that length, plus the depth of the hub, distributed along the curb. Yet even experienced contractors frequently forget this important fact. What should be done is to distribute the pipe along the curb and place an extra length at intervals of, say every twenty-four lengths or less, dependent upon distance between the ends of the pipes, so that the longitudinal roll would never be more than 12 ft. Accurate measurements are not necessary to accomplish this. Pacing the distances will be found sufficient. Constant supervision of the distributing gangs is not necessary either. The number of pipes to lay out

within a given limit may be chalked up conspicuously on the pavement, a parallel fence or some other convenient place.

Special castings weighing 300 lb. or more should be set down at a point convenient to where they will ultimately be used. It will be found most economical to locate those weighing less in a yard, near a shanty, or in some other place where a watchman is on duty at night. These light castings are a constant temptation to thieves, being readily handled, and in city streets losses from such causes are considerable.

Hydrants should also be set down where they belong. These are very seldom tampered with. But it is almost a defiance of fate to distribute the lighter valves, those under 8 in. in size, in remote places along city streets. On one large job in New York City a contractor did this with his 6-in. valves. Not only were many stripped of their readily removable brass parts, but several were opened up and gutted as well. Those valves that are so heavy as to make rehandling expensive may, with reasonable security, be distributed at the points where they belong. But the smaller brass parts should be removed and kept under lock and key. One contractor adopted the simple precaution of covering the brass parts of his valves with burlap so as to conceal them.

80-Ton Excavator Ferried Over River at Small Cost

DUE to the ingenuity of S. McIntosh, director of the Irrigation and Reclamation Works Department of Australia, a large Austin excavator was recently transferred intact across the River Murray at a cost of £50, about one-twentieth of the amount that engineers figured would be required by other means suggested. Engineers in South Australia advised him that he would have to dismantle the large machine, carry it in sections, and erect it again on the new site. The American manufacturers advised building a big pontoon and floating it across. The first method would have cost £250 and the latter several thousand pounds. It was

figured that a pontoon after construction would have been of little use for anything except as a float for the excavator.

Mr. McIntosh decided to use two barges which were required in the general operations of his department. The barges were lashed together and the big machine was run on them over heavy bridge timbers. The weight was equally divided between the two, and, towed by a steamer, the float with its strange freight crossed the river. The bulky machine then crawled once more onto terra firma.

One-Course Method Reduces Asphalt Patching Costs 15 Per Cent

By F. N. BINGHAM

Superintendent of Paving, Department of Public Works, Spokane, Washington

IN the repair of the ordinary sheet asphalt pavements which consist of a binder course and wearing surface the usual methods of using the two courses in making repairs has always seemed to me unnecessarily expensive, necessitating as it does the making of one operation in laying the binder course, and then going all over the work again in putting on the wearing surface.

In a day's work of repairing asphalt pavements, the ground covered frequently extends over several blocks, and in the case of repairing cuts made by the installation of public utilities in the newer paved districts, the repair work may extend over miles in a day's work. This not only makes two operations for the street crew, in fixing each cut, but causes an increased plant expense in handling the larger sized mineral aggregate for the binder course during part of the day, and then changing over to the finer aggregate for the wearing surface.

Every superintendent familiar with asphalt repair work realizes the difficulty in estimating the amount of material required for just the right amount of top or binder for a day's run on patch work, and therefore it is often the case that the plant foreman will prepare more binder than can be used or run the risk of not having enough.

To repair sheet asphalt pavements by the "once over" method I have used in our work here for sometime past an asphaltic concrete mixture of the following amount of asphaltic cement and mineral aggregate, and have had most excellent results with the same.

ASPHALTIC MIXTURE FOR PATCH WORK

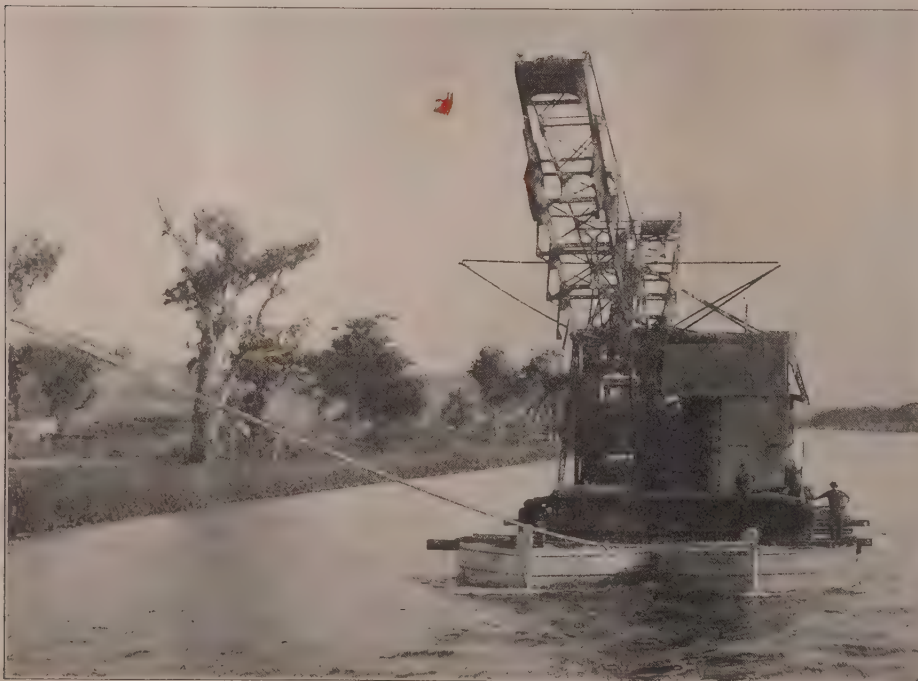
	Per Cent
Asphaltic cement	9
Mineral filler passing through 200-mesh sieve...	5
Sand passing through 80-mesh sieve.....	10
Sand passing through 40-mesh sieve.....	25
Sand passing through 10-mesh sieve.....	15
Crushed rock passing through 1/4-mesh sieve....	26
Crushed rock passing through 1/2-mesh sieve....	10
Screens used in the order named.	

The cut or worn place in the pavement to be repaired is prepared in the usual manner by cutting away the defective material until a good joint can be secured in the sound pavement and then carefully trimming the edges of the cut and painting with pure hot asphalt. If the patches are unusually large or located on a grade where there might appear to be danger of the patches creeping on the base, I paint the concrete base with a hot asphaltic paint consisting of 80 per cent asphalt and 20 per cent distillate, and then proceed to fill the holes as prepared above with the hot asphaltic concrete mixture the same as is done with sheet asphalt, using special care in tamping and smoothing the joints and securing the maximum amount of compression by rolling, and finally dusting with cement.

It is well to have the mixture to be used fairly hot, at least 300 deg. Fahr., in order to secure thorough compression by tamping and rolling.

This method might appear objectionable on the grounds that the patches made with the asphaltic concrete mixture would plainly show in contrast to the sheet asphalt pavement. However, this is not the case, and a few days after the patches are put in they are not distinguishable from the original pavement, and by this method I have been able to decrease our cost of maintenance from 15 to 20 per cent.

THE COST OF A BRICK PAVEMENT may be determined roughly by a formula given in a bulletin published recently by the U. S. Department of Agriculture. The cost of such a pavement, it is pointed out, depends so much upon so many variable factors, such as the locality, freight rates, and the distance from brick kilns, that it is not possible to make any definite estimates. The cost of the rough grading, however, should be considered entirely apart from the cost of the pavement, for the grading would have to be done no matter what kind of a road was to be built. Excluding this item, the bulletin furnishes the following formula as a rough guide for the probable expense of a brick road with a 6-in. concrete foundation and suitable grades: Cost per square yard = $1.90 L + 0.213 C + 0.138 S + 0.157 A + 0.040 B$. In this formula *C* equals cost of cement per barrel, *S* equals cost of sand per cubic yard, *A* equals cost of coarse aggregate per cubic yard, *B* equals cost of paving bricks per 1000, and *L* equals cost of labor per hour. It is assumed in this formula that all materials are delivered on the work. About 10 per cent should be allowed for wear on tools and machinery, and for every inch subtracted or added to the thickness of the foundation there will be a corresponding difference of 8 to 12 cents per square yard.



TWO BARGES CARRY CATERPILLAR EXCAVATOR ACROSS AUSTRALIAN RIVER

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Will Build Storage Reservoirs in Primeval Wilderness

The Quebec Streams Commission has given a contract to the St. Maurice Construction Company of Montreal for the construction of the St. Maurice storage dam, which will impound 160,000,000,000 cu. ft. of water. The object of the storage is to improve the power conditions of the St. Maurice River. Fraser, Brace & Company, Ltd., Power Building, Montreal, will supervise the work for the contractor. The dam will contain 70,000 cu. yd. of concrete.

The dam is located on the St. Maurice at a point fifty miles from the nearest habitation and thirty-five miles from the nearest point on the Transcontinental Railroad. The getting in of supplies, therefore, will prove a very difficult task. That problem has not yet been solved, but the expectation is that it will be possible to use the river for about thirty miles and a narrow gage line for the remainder of the distance.

The project was described by J. W. Thurso in the Engineering Record of Oct. 10, 1914, page 395, and Oct. 31, 1914, page 490.

Engineering Company Granted Decision in Infringement Suit

The Cleveland Dock Engineering Company of Cleveland has been granted a decree sustaining its patent to a special type of concrete dock, built in 1907, for the Detroit Iron & Steel Company, a subsidiary of the M. A. Hanna Company, restraining the latter company from further infringement and calling for an accounting. After the original dock was completed the Detroit Iron & Steel Company, undertook extension to it, in 1913, ignoring the original engineers and the designers, it was claimed, and practically duplicating the original design. The dock design as originally developed and used consists essentially of a

lyn company will pay one-half of the annual premium on insurance up to \$1,000 and, in certain cases, the total premium.

Grand River Roller Crests and Accessories Weigh About 280 Tons

The roller crests of the Grand River Roller Dam, in Colorado, which are shown in the accompanying illustrations, weigh, with accessories, about 560,000 lb. They are seven in number, six having a length of 70 ft. and a height of 10¼ ft., and one having a length of 60 ft. and a height of 15½ ft. The dam, as a whole, consists of an ogee masonry weir with



PIER DETAIL AND END OF ROLLER



ROLLERS RAISED TO PERMIT FLOOD WATERS TO PASS THROUGH DAM WITHOUT ENDANGERING RAILROAD TRACKS

heavy girder wall, supported on piles, connecting integrally with a heavy floor or deck, extending back to a parallel shore or tight wall, properly supported. The case was tried in the U. S. District Court, Eastern District of Michigan, sitting at Detroit. Judge Tuttle presided.

Transit System to Aid Employees in Life Insurance Payments

The Brooklyn Rapid Transit Company, New York City, has entered into an agreement with the Travelers' Insurance Company of Hartford, Conn., whereby that company will insure the lives of employees of the transit system under the group insurance plan. The Brook-

lyn company will pay one-half of the annual premium on insurance up to \$1,000 and, in certain cases, the total premium.

the roller crests. The maximum height of dam is 24 ft., the length of weir, 546 ft. The volume of concrete used in its construction totaled 16,500 cu. yd. The main canal from the headworks has a capacity of 1400 sec. ft. The mean monthly flow of the Grand River, at Palisade, Col., varied from 1200 sec. ft. to about 33,000 sec. ft. in the period between 1902 and 1911.

The reason for the installation of this type of dam was that the Denver & Rio Grande Railroad, at the point of crossing, is about 3 ft. above water level and the rolling crest was adopted in order to keep the level of the water approximately constant by raising the rollers and permitting flood waters to pass through the dam.

Pioneer Heading at Rogers Pass Tunnel Is Finished

Remarkable Records Result of Sustained Effort as 452 Feet Is Lowest Average Monthly Progress on Any Heading for 1915

The month of July saw the completion of the pioneer heading at the Rogers Pass Tunnel on the Canadian-Pacific Railway near Glacier, B. C. At the same time the greatest progress for the job in enlarging the main heading for double track was made, 812 ft. of the west end of the tunnel having been excavated and timbered during July. The largest month's progress of enlargement for double track on the east end, 726 ft., was also recorded for the month of July. The best progress on the pioneer headings was 808 ft. for June and 932 ft. for January, 1915, both made in the west heading. This last figure is the American record for progress in any size tunnel. The best month's work in the east pioneer heading was 776 ft. for June, so that June was the high month for the pioneer bore, with 1584 ft. of progress made in both headings.

Record on Main Heading

The highest progress made in a main heading was in March, when the heading at the west end was advanced 752 ft. The lowest full month's work in any heading has been 393 ft., which was the progress made in the west main heading in June.

High Average Progress

The average monthly progress shows that the records made have been backed by sustained effort, and are not merely the result of favorable conditions.

Progress on the entire work for the seven months averaged as follows: Pioneer headings, east, 668 ft.; west, 719 ft.; main headings, east, 452 ft.; west, 601 ft., and en-

largement for double track, east, 554 ft.; west, 526 ft.

There remains to be driven 2.05 miles of main heading and 3.31 miles of double track enlargement. The concrete lining of the earth section is nearing completion, and it is expected that all the rock section which requires lining will be concreted this year. The completed tunnel will probably be ready for operation in September, 1916.

A description of the methods used on this remarkable contract, which is being carried out by Foley Bros., Welch & Stewart, under A. C. Dennis as superintendent, will be found on page 604 of the Engineering Record for Dec. 5, 1914, when the work was in the early stages of construction.

Los Angeles \$1,000,000 Municipal Dock Completed

Municipal Dock No. 1, in the outer harbor of San Pedro, Cal., costing nearly \$1,000,000, is practically completed and will soon be formally dedicated. Work on the structure was begun in April, 1912, and its completion is said to represent one of the largest harbor improvement schemes ever undertaken by a municipality. Sixty-six acres of land were reclaimed by the city before the work started. The completed structure includes a reinforced concrete wharf 2520 ft. long and a transit shed of steel and concrete 1800 ft. long and containing 180,000 sq. ft. of floor space. Foundation piles for the construction of a proposed six-story warehouse, 480 x 152 ft. in size, with approximately ten acres of floor space, are now being driven. Channels 35 ft. deep will accommodate the largest sized steamers. The approximate cost of the various units composing the ultimate structure may be stated roughly as follows: fill, dock, shed and proposed railroad spurs, \$897,000; transit shed, \$250,000 reinforced concrete dock, \$444,000.

Concrete Road Congress Sub-Committee Organization Completed

The organization of sub-committees for the Second National Conference on Concrete Road Building to be held in Chicago, Feb. 15-18, 1916, has been completed. Seventeen committees have been named. Each of them will investigate a specific topic in connection with the construction of concrete roads and will submit a report on it. The committees are made up of college and university professors, engineers, contractors and State, city and county officials. The topics cover questions of design, aggregates, proportions of materials, joints, construction problems, estimates, specifications and maintenance.

The program for this conference will follow the general lines worked out for the first meeting, with the exception of a few changes dictated by new conditions. The advisory committee has again elected Dr. W. F. M. Goss, dean of the college of engineering of the University of Illinois, as chairman, and J. P. Beck, as secretary. An invitation is extended to all interested in highway improvements to correspond with the secretary and to participate in the conference.

The secretary's office is at 208 S. La Salle Street, Chicago.

Sanitary District North of Chicago Engages Engineering Talent

The North Shore Sanitary District, an area along Lake Michigan 20 miles long and about 1 mile wide in Lake county, Illinois, has appointed John W. Alvord, Harrison P. Eddy and George W. Fuller as a commission of engineers to determine a method of disposing of the sewage in the district. Preliminary data, consisting of drawings of sewage systems, underground conditions, material costs, water supply conditions and sewage gagings have been collected and collated in a report submitted in June by Langdon Pearse and S. A. Greeley, the local work being done by R. J. Smith and C. E. Russell of Waukegan.

New York's Payroll Report Shows Decreases in Some Departments

Considerable decreases are shown in the salary disbursements during 1914 as compared to the preceding year of various city departments in New York City which generally employ large forces of engineers, according to a report submitted to the Board of Estimate and Apportionment by Comptroller Prendergast. The Bridge Department shows a reduction of \$144,060, the Department of Docks and Ferries, \$193,586, the Department of Water Supply, Gas and Electricity, \$325,969, and the Board of Water Supply, \$386,809. Increases

are shown in various other departments to such an extent that the city's payroll, as a whole, shows an increase of almost \$4,000,000 over that of 1913.

New York Public Service Commissions Adopt First Joint Order

For the first time in the history of the commissions, the New York State Public Service Commission of the First District and that of the Second District, sitting at a joint meeting to consider the removal of grade crossings and other obstructions on the lines of the New York & Harlem River Railroad and the New York, New Haven & Hartford, adopted, during the week of Aug. 2 to 6, a joint order providing for such removal. The obstructions in question are located near 241 Street in the Borough of the Bronx, New York City. The order calls for a shifting of the tracks and the construction of a viaduct to carry the street

classic style of the educational group, the main building with a conventional triglyph frieze, the pavilions differing somewhat in detail.

Entering the building through the portico the visitor will find himself in a spacious tripartite lobby, which will be the living room. Comfortable cosy corners will abound, for many angles are provided. There will be two open fireplaces in the lobby and others in adjacent rooms. To the left will be the dining room and to the right a spacious lounge, eighty to ninety feet in length. The whole rear of the first floor will give space for an auditorium for about five hundred, centrally disposed in the width of the building. The second floor will have reading, writing and social rooms, a library and a room devoted to the use of faculty and alumni. The third story will be divided into many small rooms, which are to be the homes of the many student activities. The basement will contain kitchen, service and

Restoring Bridge Destroyed During the War in France



MOST OF THE WAR PICTURES OF BRIDGES RECEIVED IN THIS COUNTRY SHOW MERELY THE DEMOLISHED STRUCTURE. THIS VIEW INDICATES HOW THE ESTACADE BRIDGE OVER THE MARNE IS BEING REPLACED BY THE USE OF PONTOONS

at that point so that the present dangerous and inconvenient conditions will be done away with, and that the full effect of recent grade crossing improvements at Mount Vernon, which is in the Second District, may be realized. These improvements were ordered some time ago, but, owing to conditions in New York City, the new highway could not be opened until a connection from the New York City end was provided.

Memorial Will Be Central Feature of New Technology Group

The Walker Memorial, the student club house, will be the central feature of the new group of buildings now in the course of erection along the Charles River Basin for the Massachusetts Institute of Technology, which was described in the Engineering Record, Nov. 15, 1913, page 48; April 4, 1914, page 393, and May 15, 1915, page 634. It will be a building of about one hundred and fifty feet front and three stories in height, and will cost about \$250,000. It will stand at an elevation above the street level so that the basement will be high studded and well lighted. The main floor will be approached from the river front by broad steps leading to a curved pillared portico two stories in height, above which the building will continue up another story on the line of the wall behind the portico. Pavilions with engaged columns, the latter also two stories in height, define the ends of the structure, standing somewhat forward of the main facade.

The architecture is to be of the simple

utility rooms, a small gymnasium, showers and toilets. The building is so planned and the others, with reference to it, that available land for future extension to more than double its original size will be available.

Sewage Disposal Commission in Chicago Abolished

After three years of work and without waiting for a final report the Sanitary District of Chicago has abolished its commission of engineers appointed to investigate the development of water power and the best method of sewage treatment. A report was made on the power plant development and the disposal of electricity last winter. The members of the Commission were L. E. Cooley, John Ericson, W. A. Artingstall, L. K. Sherman and Henry M. Walker.

International Engineering Congress Has Almost 3000 Members

Up to July 12, 2927 members were enrolled on the books of the International Engineering Congress. The American Society of Civil Engineers furnished 10.1 per cent of the total membership. The foreign membership is only 27 per cent of the total enrollment. California, with 466 members, New York, with 446, Pennsylvania, with 176, and Illinois with 111, lead all other States and foreign countries in the order named, in the number of members resident within their boundary lines. Up to July 12, 192 papers had been received.

Chicago's Smoke Committee Claims Railroad Electrification Unfeasible

That Chicago does not need electrification of its railroads and that the proposition is not feasible is the position taken by the Committee on Smoke Abatement and Terminal Electrification of the Chicago Association of Commerce according to the Chicago newspapers. The information came to them from Washington correspondents, who claimed to have access to a copy of the report. No confirmation could be obtained from the Chicago office, and furthermore it was declared that no information would be given out before Sept. 15. The following notes are taken from the Washington account. Intimations have come from various quarters that the findings which were adopted in June were adverse to the electrification propaganda. The complete report, the despatch says, bears out the prediction. The cost was fixed at more than \$200,000,000. Electrification projects are figured for 4501 miles of track, of which 2819 miles are within the city limits. Some of the items of expense are 1600 locomotives at \$40,000 apiece and power houses of a capacity of 1,000,000 to 1,500,000 kw. at \$100 per kilowatt.

With regard to smoke, the steam locomotives at present are charged with 22.06 per cent only. One of the members of the committee when smoke inspector of the city in 1911 reported that 43 per cent of the smoke came from railroads (see Engineering Record, April 15, 1911, page 426).

Health Association to Hold Annual Meeting Sept. 6 to 10

The annual meeting of the American Public Health Association will be held at Rochester, N. Y., Sept. 6 to 10. The first session of the sanitary engineering section will be a joint meeting with the laboratory section.

Will Hold Water-Power Conference at Portland, Oregon

As the result of a resolution passed by the Oregon Legislature last spring, empowering the Governor of Oregon to send invitations to various States to participate in such a conference, a water-power conference will be held at Portland, Oregon, Sept. 21, 22 and 23. Oregon, Washington and Idaho are especially interested in National water-power legislation. A very considerable portion of the streams in these States that are capable of hydroelectric power development are situated on Federal lands of various sorts. It is hoped that the conference will bring to a focus various thoughts on the subject of water-power legislation that may result in putting the matter before Congress in such a way that some definite results may be secured at the coming session of the National body.

Take Steps Toward Enforcement of New York Jitney Bus Law

The Public Service Commission, Second District, New York State has taken its first steps toward the enforcement of the New York jitney bus law, passed at the last session of the Legislature, by applying to a supreme court justice, at Kingston, for a permanent injunction restraining two individuals in Rochester from operating jitney lines without the consent of the local authorities or a certificate of public convenience and necessity from the commission. The law requires that all bus lines, motor vehicles, stage routes, any vehicle carrying passengers for 15 cents or less, or any vehicle operating in competition with a common carrier must procure the consent of the local authorities or obtain a certificate of public convenience and necessity from the Public Service Commission before operating in the streets of any of the cities of the State. The statute, in specific terms,

makes all negaging in the jitney business, as defined, common carriers and subject to all provisions of the law as such.

Urge Appointment of Five Engineers to Solve Cedar Lake Problem

Committees representative of the Pacific Northwest Society of Engineers, the Municipal League of Seattle and the new Seattle Board of Commerce have jointly recommended to the City Council of Seattle, Wash., that a board of five engineers be appointed to study the leakage problem at Cedar Lake Reservoir and to devise a method of remedying it.

Automobile Rural Mail Delivery Routes Go Into Operation

Two hundred and eight automobile rural mail delivery routes in the United States went into operation Aug. 2. They will cover a total stretch of about 11,440 miles, distributed in Oklahoma, California, Georgia, Colorado, Kansas, Louisiana, Florida and Texas.

Clay Products in 1914 Indicate a General Growth of the Industry

The brick and clay industries of the United States, in 1914, produced material to the value of \$129,588,822, according to the U. S. Geological Survey. Though this is a considerable decrease as compared to the production in 1913, it shows a general growth for the industry as compared to previous years.

Common brick, as judged by value, comprised over one third of the value of all brick and tile products in the past year. The total value produced was \$43,769,524. Fire brick, at \$16,427,574, ranked second in value. Sewer pipe was produced to a total value of \$14,014,767, vitrified paving brick to a value of \$12,500,866, drain tile to a value of \$8,385,337 and fireproofing, including hollow building tile, to a value of \$8,385,337.

Personal Notes

J. W. Hamilton has been appointed city engineer of Pasco, Wash.

Carl Olsen has been appointed city engineer and superintendent of waterworks of Rhinelander, Wis.

William L. Bradley, formerly division engineer of the Atchison, Topeka & Santa Fé Railway at Fresno, Cal., has been appointed division engineer at Needles, Cal.

J. W. Haynes has been appointed assistant engineer to I. A. Baum, city engineer of Texarkana, Ark. Mr. Haynes was graduated from the University of Mississippi in 1914.

M. C. Bryan, formerly division engineer for the Atchison, Topeka & Santa Fé Railway at San Bernardino, Cal., has been transferred to the Albuquerque division, with headquarters at Winslow.

Commonwealth Engineering Company, formerly located in the Plaza Building, and later in the Emerson Building, Oakland, Cal., has moved its offices to the Rialto Building, San Francisco.

P. C. McArdle, assistant State highway engineer of Illinois, has been granted a leave of absence to become consulting engineer of Vermillion County, in connection with its projected road system.

G. J. Bell, formerly division engineer on the Atchison, Topeka & Santa Fé Railway at Marceline, Mo., has been appointed engineer of the western district of the Eastern Lines at Newton, Kan.

Walter W. Weir, drainage engineer of the U. S. Department of Agriculture, has been assigned to Stockton, Cal., to make an investigation of drainage conditions in the South San Joaquin Irrigation District.

James W. Routh, formerly a member of the public works staff of the New York City Bureau of Municipal Research, has been appointed engineer on the staff of the Rochester Bureau of Municipal Research.

M. C. Blanchard, formerly office engineer for the Atchison, Topeka and Santa Fé Railway at Topeka, Kan., has been appointed engineer of the eastern division of the Eastern Lines. His headquarters will continue to be at Topeka.

L. L. Holladay has become associated with Henry Negstad in his consulting practice in the field of power plants, utilities and industries. The new firm, Holladay, Negstad & Company, has offices at 109 North Dearborn Street, Chicago.

G. A. Flink, consulting and construction engineer, of Harrisburg, Pa., has been selected by the Governor of Pennsylvania to prepare plans for and supervise the construction of the proposed \$60,000 concrete bridge to be built in Northumberland County.

Rudolph Hering, hydraulic and sanitary engineer, of the firm of Hering & Gregory of New York City, has been retained by the city of Johnstown, Pa., to pass upon the plans for the proposed sanitary sewerage system and sewage disposal plant for that city.

H. A. Kluegel, civil engineer of Oroville, Cal., has been retained to assist in an investigation relative to the proposed new water supply for Denver, Col. Mr. Kluegel has had considerable experience in railroad, water supply and hydroelectric work in Hawaii and on the Pacific Coast.

R. A. Riley, formerly of the contracting firm of Evans & Riley of Pottsville, Pa., is forming a new company for the purpose of engaging in a contracting business, at Pottsville, in partnership with H. O. Knapp. The Riley-Knapp Construction Company is located in the Biddal Building.

W. C. Baisinger, formerly division engineer for the Atchison, Topeka & Santa Fé Railway at Chanute, Kan., has been appointed division engineer at Marceline, Mo., succeeding G. J. Bell, whose appointment to another office is noted elsewhere in these columns. Mr. Baisinger is succeeded by H. A. Hatch.

Elmer H. Olsen, formerly assistant engineer on the Gulf, Colorado & Santa Fé Railway at Galveston, Tex., has been appointed office engineer on the Atchison, Topeka & Santa Fé at Topeka, Kan., succeeding M. C. Blanchard, whose appointment to another position is noted elsewhere in these columns.

James S. S. Jones has been transferred from the field service of the U. S. Coast and Geodetic Survey to the position of computer in the tidal division. This division furnishes the survey parties with all tidal data necessary for soundings and has charge of the preparation of tide tables for the United States.

Charles G. Atkin, formerly connected with the Hyde-McFarlin-Burke Company, contractors, of New York City, has been appointed civil engineer on the forces of the Acme Contracting Company, at Herkimer, N. Y. Previous to entering the contracting field Mr. Atkin served as assistant civil engineer in the department of the State engineer of New York.

John N. Carlisle, who was retained in an advisory capacity by the Highway Department of New York State, upon his retirement from the office of State highway commissioner early in the year, resigned from that department, Aug. 8. He was appointed State highway commissioner by Governor Sulzer in 1913 and was succeeded in that office in March of the present year by Edwin Duffey.

Bickel Company, engineers and constructors of Kansas City, Mo., has taken over the business formerly conducted by the Commercial Construction Company, Reliance Building, Kansas City. This is merely a change of name, the officers and policies of both companies being the same. The Bickel Company has

established offices in the Interstate Building and will specialize in municipal and factory work.

Joseph Weidel, formerly assistant engineer on the Atchison, Topeka & Santa Fé Railway at Lubbock, Tex., has been appointed valuation engineer on the same road, with headquarters at Chicago. He was graduated from the Agricultural and Mechanical College of Texas in 1893 and entered railway service on the Atchison, Topeka & Santa Fé in 1900. He attained the grade of assistant engineer about two years later.

Edgar E. Ball, formerly division engineer of the Atchison, Topeka & Santa Fé Railway at Los Angeles, has been appointed division engineer of the Valley division at Los Angeles, succeeding William L. Bradley, whose appointment to another division is noted elsewhere in these columns. Mr. Ball entered the service of the Atchison, Topeka & Santa Fé in 1897 and was engineer of construction on the construction of the second track of the Albuquerque division, total cost of which was about \$5,000,000.

Alvin A. Horwege has been appointed city engineer of Petaluma, Cal. He received his professional education at the Polytechnic College of Engineering, at Oakland, Cal., and entered the service of the Southern Pacific Railroad in 1908. From 1910 to 1912 he was connected with the Board of Public Works of the city of San Francisco on the construction of various sewers. He also served on the forces of the Great Western Power Company, the Warren Improvement Company, the Sierra & San Francisco Power Company, and, as assistant engineer, under the superintendent of construction and repair of the Board of State Harbor Commissioners, at San Francisco.

H. M. Roy, formerly chief field engineer with the American Zinc & Chemical Company on the construction of its zinc smelter plant, modern town and 1500-ton coal mine at Langloth, Pa., has accepted the position of engineer, with the Stone & Webster Engineering Corporation, on the construction of a zinc smelter plant at Keokuk, Iowa. He was graduated from the University of Illinois in 1905 and, after two years spent in the service of the U. S. Coast and Geodetic Survey on harbor surveys and precise leveling, entered the engineering department of the Pennsylvania Lines West of Pittsburgh, where he was engaged on construction and maintenance work until 1913. He left railroad work to accept the appointment on the forces of the American Zinc & Chemical Company.

Vernon M. Eager, civil and drainage engineer of South Bend, Wash., has established a branch office at Cathlamet, Wash., where he is engaged as construction engineer in charge of the construction of State Road 19, a unit of the State highway system. This unit will ultimately comprise 35 miles of permanent highway, extending through Wahkiakum County. Mr. Eager received his professional education at Washington State College and began work as chainman for B. W. Huntoon at Bellingham, Wash. He served as deputy county engineer of Whatcom County, Wash., from 1909 to 1910, and as deputy county engineer of Pacific County, from 1910 to 1911. He was appointed city engineer of South Bend in 1911 and occupied that office until 1913, when he resigned to engage in private practice.

Edgar L. Tenny, who for a number of years past has been in the designing and estimating department of the Illinois Steel Company, North Works, has opened an office in the Monadnock Building, Chicago, to engage in practice as a consulting engineer. He was graduated from Iowa State College in 1904 and entered the employ of the General Electric Company soon after. He was engaged in construction work for the Indiana Steel Company during the period of building the plant at Gary, Ind. For a number of years following he was bridge designer for the Chicago & Northwestern Railway Company. During his service with the Illinois Steel Com-

pany he made a specialty of derrick design, which he proposes to include in his consulting field, along with bridges, buildings and foundations.

Charles B. Buerger has resigned from the position of principal assistant engineer of the firm of George W. Fuller, consulting engineer, of New York City, to accept an appointment as consulting engineer for the Atlantic Refining Company of Philadelphia. Mr. Buerger joined the staff of Mr. Fuller in 1913, having been previously senior assistant engineer in the filtration division of the Department of Water Supply, Gas and Electricity of New York City. He was graduated from the College of the City of New York in 1898, and from Stevens Institute in 1900. He was connected with the Atlantic Refining Company once before, having been in charge of mechanical equipment and designer in its service from 1900 to 1903. He also served for several years on the engineering forces of the Bureau of Water of the city of Philadelphia.

Herbert A. Whitney, formerly hydraulic engineer of the city of San Diego, Cal., has been appointed consulting engineer for the California State Highway Commission. His first engagement along engineering lines was as draftsman for F. W. Wheeler's Ship Yard, at Bay City, Mich., from 1893 to 1896. In the latter year he was appointed surveyor in the city engineer's office at Bay City, where he remained until 1898. From 1908 until 1910 he served as hydraulic engineer and water superintendent for the city of Tacoma, Wash., and, from 1910 to 1912, as city engineer of Bellingham, Wash. He was appointed hydraulic engineer for San Diego in 1912. In this capacity he had charge of the design and construction of waterworks improvements to a value of \$2,500,000, including distributing systems, subaqueous pipe lines, pumping plants, conduits and three dams.

Morris Knowles, consulting engineer, of Pittsburgh, has acquired the engineering business formerly conducted from offices in Pittsburgh and Canton, Ohio, by the late Loomis E. Chapin, whose death was noted in this journal, June 26. Mr. Knowles was graduated from Massachusetts Institute of Technology in 1891 and began professional work as assistant engineer for the East Jersey Water Company, at Newfoundland, N. J. He was associated with Mr. Chapin for several years, the partnership being formed in 1902 and terminating with Mr. Knowles' appointment as chief engineer of the Bureau of Filtration of the City of Pittsburgh. He opened offices to practise as consulting engineer in Pittsburgh under his own name in the latter part of 1910. He will conduct the combined business from his office in the Oliver Building, continuing to specialize in waterworks, water-power, sewerage, sewage treatment and disposal, sanitary investigation, town planning, flood prevention and valuation work.

Thomas J. Gannon has opened an office at 143 Liberty Street, New York City, to engage in practice as consulting mechanical and hydraulic engineer on power plants, water supply, sewage disposal, coal and fuel economy, mechanical equipment and testing and reports. Mr. Gannon was graduated from Lehigh University in 1892, after having spent four years in practical work in the shops of the Bethlehem Steel Company. From 1892 to 1896 he was engaged alternately in the employ of the Bethlehem Steel Company and in post-graduate work at Lehigh. From then until 1902 he was employed by the New York Sugar Refining Company, Westinghouse Church Kerr & Company, J. G. White & Company, and the United Coke & Gas Company successively. He was appointed mechanical engineer on the forces of the Department of Water Supply, Gas and Electricity of the City of New York in 1902, in responsible charge of the mechanical work of that department, and continued in this service until recently. The present standards of that department for pipes, special castings, valve boxes, hydrants and gate valves were prepared by him.

G. F. Stickney, formerly consulting engineer for the Lake Erie & Ohio River Canal, having recently completed the preliminary investigations for that project, has opened offices in the Arkay Building, Albany, N. Y., for the purpose of practising as consulting engineer. He was graduated from Sheffield Scientific School, Yale University, in 1891 and served from then until 1893 as rodman, leveler and resident engineer successively for the Mexican International Railway. From the latter year until 1895 he was U. S. assistant engineer on river improvement work in Kentucky. At the outbreak of the Spanish-American War, in 1898, he was commissioned as captain, in command of Company C of the Third Regiment, U. S. V. Engineers, serving in the United States and Cuba. From 1901 to 1902 he was assistant engineer for the Lake Superior Power Company, and, from 1904 to 1905, U. S. assistant engineer on river and harbor improvements in the vicinity of New York City. Resigning from this office he entered the service of the State of New York, where, as supervising engineer on the State Barge Canal, he had charge of the preparation of a considerable part of the plans for that waterway. He left this work to become consulting engineer on the Lake Erie & Ohio River Canal.

Charles D. McArthur, who since April, 1914, has been chief engineer for Foley Brothers, Welch, Stewart & Faquier, contractors, of Halifax, N. S., on work in connection with the construction of the first unit of the Halifax Ocean Terminal for the Intercolonial Railway of Canada, has again assumed the office of chief engineer of the Blaw Steel Construction Company of Pittsburgh, and will be in personal charge of its engineering service department. All form problems requiring special design will be handled under his direct supervision. He received his professional education at Antioch College, Yellow Springs, Ohio, and was in the service of the Gleason Tool Company of Rochester from 1899 to 1900, engaged in the design of metal-working machinery. From 1900 to 1903 he was mechanical engineer in the motive power department of the Buffalo, Rochester & Pittsburgh Railway, and from 1905 to 1906 was designing engineer for the building bureau of the New York City Board of Education. He was originally appointed chief engineer for the Blaw Steel Construction Company in 1908, in which capacity he developed forms for the Panama Canal, the Catskill Aqueduct and the New York City and Boston subways. He resigned from this office in 1914 to take up the work at Halifax.

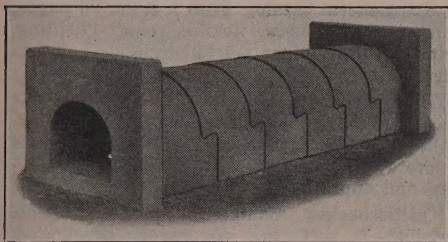
Civil Service Examinations

Examinations Previously Announced

Date	See Eng. Record.
Aug. 17-18—Senior, Grade 1 and 2, and junior land appraisers, salaries from \$2,700 to \$3,600, from \$1,800 to \$2,400 and from \$900 to \$1,500 respectively; United States	July 24
Aug. 17-18—Senior drainage, drainage and junior drainage engineers, Department of Agriculture, salaries from \$2,220 to \$3,000, from \$1,800 to \$2,100 and from \$960 to \$1,620 respectively; United States	July 31
Aug. 25-26—Junior civil engineer, Engineering Department; United States	July 31
Sept. 15—Aid, U. S. Coast and Geodetic Survey. Draftsman and junior engineer, U. S. Engineer Department....	July 3
Oct. 13—Aid, U. S. Bureau of Standards. Civil Engineer and Draftsman. Draftsman, Navy Department. Engineer, Indian Service....	July 3

Interlocking Concrete Culvert

Expansion joints as protection against frost action, smooth interior as an aid to the flow of water, flat base and perpendicular sides, together with square end blocks, to insure a permanent setting, and an interlocking device are some of the features of the Hall Interlocking Concrete Culvert which has recently been



CULVERT MAY BE BUILT TO ANY LENGTH

placed on the market. The culvert sections are all reinforced. The steel forms used in manufacturing the culvert can make five sections at one casting. Both end blocks, being oppositely locked, are cast together. Sections can be fitted together to obtain any desired length. The forms for the new culvert, which come in seven sizes ranging from 12 to 48 in., are manufactured by Schulz & Hodgson, 19 South La Salle Street, Chicago.

Bonds Plaster to Concrete and New Concrete to Old

To make plaster adhere satisfactorily to a concrete surface a process known as "Par-Lock," which consists essentially of applying with patented apparatus a film of waterproofing compound to the concrete surface, and then sticking into the surface of this film by means of a low pressure blast a coating of coarse sand, has been in use about eighteen months, and is said to have solved the difficulties involved at a reasonable cost.

The apparatus, shown in the accompanying photograph, consists of an air-tank mounted horizontally, a tank under pressure containing the mastic, and a third tank containing the carefully screened and washed coarse sand, on which 6 to 8 lb. pressure is carried. The mastic is fed through a hose to a special nozzle, where it is projected into an air blast, carried to that point independently, which is under 50 lb. pressure. This blast carries the mastic through an outer nozzle and projects it with great force against the surface to be coated. All holes are filled, and it is said even the larger ones, such as nail holes, are

permanently filmed over. This work is followed very closely by the sand blast. The result is a rough surface that bonds effectively with the plaster, and is said to quite prevent its flaking and falling from ceilings. The process, it is claimed, has also been used with success in bonding old and new concrete work.

The mastic used is an asphalt-gum compound carried in a volatile hydrocarbon medium. This latter entirely evaporates in four days, leaving a surface which can be plastered at any time thereafter. Hardening begins as soon as the mastic is applied, so that it must be sanded within a short time. As the mastic is waterproof the plaster is protected from all strains due to efflorescence from the concrete, or to water finding its way through the concrete from the outside.

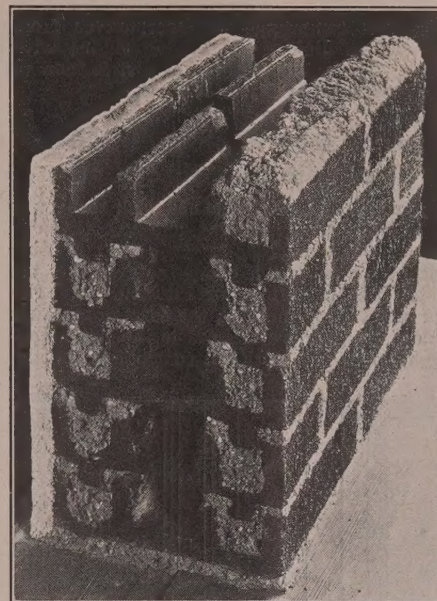
Tests made by the Industrial Testing Laboratory of Cleveland indicate that the tensile strength of the mastic is 240 lb. per square inch, and that it grips the sand grains with a strength of 160 lb. per square inch. Its bond with the surface to which it is applied is so good that test specimens break either in the concrete or in the material later applied to the sanded surface.

The process was used on the East Milwaukee School of Milwaukee and on a large number of concrete school buildings in Cleveland. It is now being applied to a concrete building of the Curtis Publishing Company in Philadelphia, where trouble with falling plaster had been experienced. The process is used to coat brick and other structural surfaces. The mastic used is known as "Lifekote Damp-Proof Bond," and is furnished by the Union Products Company of Cleveland. The following operating companies apply the "Par-Lock" process: the Mastic Bond Company, Inc., of New York City, the Bagnall-Taylor Company of Cleveland, and the Waterproof Plaster Key Company of Chicago.

New Interlocking Brick Has Insulating and Damp-Proof Features

A new type of interlocking channel brick, providing a double wall containing a 2-in. air space which serves as an insulation against heat, cold and moisture, has been placed on the market by Fiske & Company, Inc., 40 West Thirty-second Street, New York City. The material is known as "Fisklock" tapestry brick and its characteristics are shown in the accompanying illustration.

Only one row of blocks per course is needed for a wall 8-in. thick. As compared with ordinary brick, therefore, the operations of a mason in laying a wall are reduced. The channel of the new brick is 2 in. wide so that webs of the blocks may be grasped readily



AIR SPACE IN WALL OF INTERLOCKED BRICK INSULATES AGAINST HEAT AND COLD; THERE ARE NO THROUGH MORTAR JOINTS

with one hand. No inside construction scaffolding is needed as there is no backing-up wall to lay. Special features of the new construction are the bond secured by the interlocking feature and the fact that there is no mortar joint extending through the wall, one of the reasons cited to substantiate claims for damp-proofness.

Tests of an 8 x 8 in. pier 6 ft. high at Columbia University developed an ultimate crushing strength of 109 tons per square foot, gross area. A fire test of a wall also was made, and the construction passed the specifications of the proposed building code of New York City.

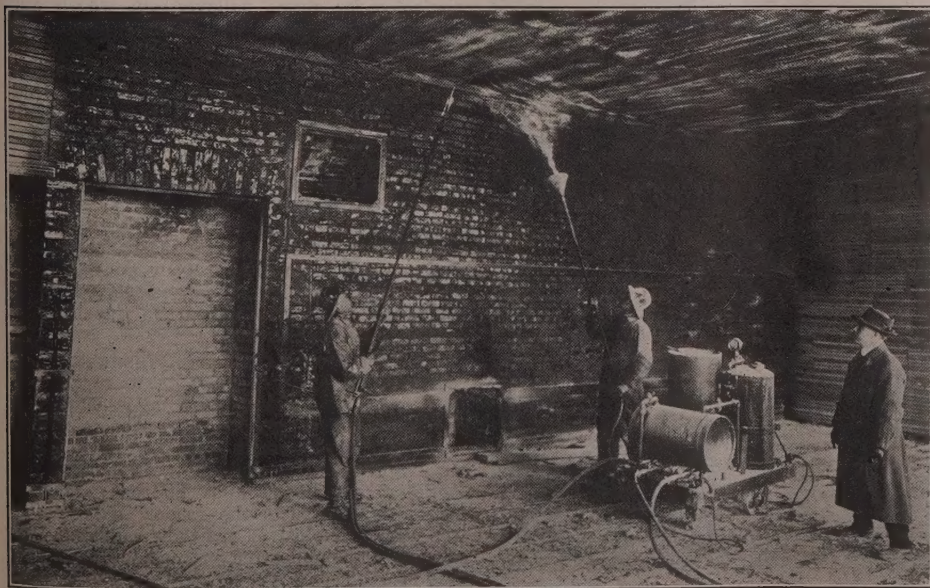
With the introduction of this new material the company has adopted a sales policy claimed to be entirely new in the brick business—a frankly advertised "open price," uniform to all.

Want Data on Hauling Capacity? Get This Catalog

A good share of the existing information about the tractive force of locomotives, the effect and amount of rolling friction with different kinds of equipment on various grades and curvatures, and tables checked by actual tests giving the hauling capacity of Porter locomotives for different equipment and varying conditions are included in the second part of the new catalog of the H. K. Porter Company of Pittsburgh, just published. Simple engineering formulae and tables are given which would enable a contractor who is not an engineer to measure grades and curves on an existing track, or determine them for a new one, and select the proper size and type of locomotive to haul a given number of cars of a certain type over the line at the most economical speed. To an engineer confronted with this same problem the book will prove of great use, as it gathers between two covers the recent and complete data on these subjects. Master mechanics will find some useful hints on the care of boiler flues.

The third part of the catalog contains tables of operating costs, and of the cost of track per mile, arranged so as to give this cost for any price of materials. The weight, size, load capacity and cubic contents of standard railway, contractor's and industrial rolling stock are given. A table giving the proper weight of rail for different sizes of locomotives is also included. Weights of lumber and track materials and metric conversion tables are included.

The trade part of the catalog describes

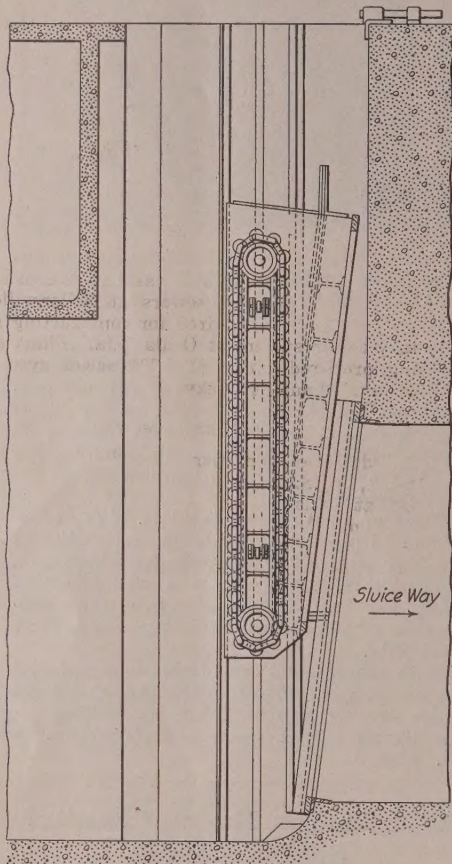


MAN AT LEFT SPRAYING MASTIC, MAN IN CENTER PUTTING ON SAND

steam and compressed air locomotives from the 6,000-lb. dinky to a 190-ton engine with tender. The publication is for distribution to those interested at the price of \$1.

Inclined Seat Eliminates Sliding Friction in New Sluice Gate

By means of a seat, inclined with respect to the vertical gate movement, sliding friction is practically eliminated in the new Broome sluice gate, which is manufactured by the Exeter Machine Works of Pittston, Pa. The deck plate, being inclined, the forces operating to close the gate are reduced to the submerged weight plus the vertical component of the



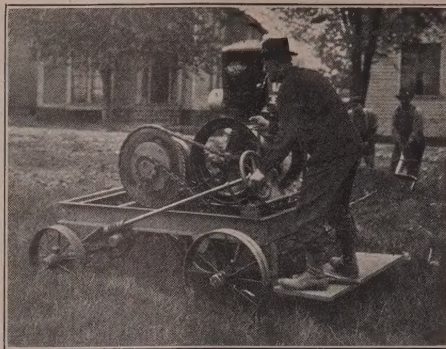
SLUICE GATE OPERATES WITH LITTLE FRICTION

water pressure. Consequently, the supporting mechanism is always in tension, whether operating or closing. This does away with heavy compression stems and permits the use of the gate for extreme heads. Guideways are unobstructed to the full depth so that the gate is readily accessible for inspection. It is supported at the sides by endless roller chains, which bear on tracks attached to the movable gate and on guides supported on the masonry structure. On each side, at top and bottom, are squaring rollers, useful chiefly for securing minimum side clearance.

Simplicity of Operation Feature of This Back Filler

High broad-tired wheels, which prevent it from sinking to any extent in soft soil, ability of the operator to move it in any direction, backward or forward, without shifting his position, and plenty of power, are features of the latest back filling machine to be placed on the market. It is equipped with a 6 hp. Novo engine and the clutch used in pulling the cable is of the standard hoisting engine type. It is also provided with a break for holding the line when raising pipe, and a ratchet and pall which allows the hoist to be set permanently.

A multiple disc clutch is used in connection with the traction arrangement. The line or cable comes from the drag to the machine and is run through a swiveled sheave, which allows



NEW BACK FILLER IS EASY TO HANDLE

it to turn in any direction and thus permits the operator to work the scraper from any point. The new machine is manufactured by the Oshkosh Manufacturing Company, Oshkosh, Wis.

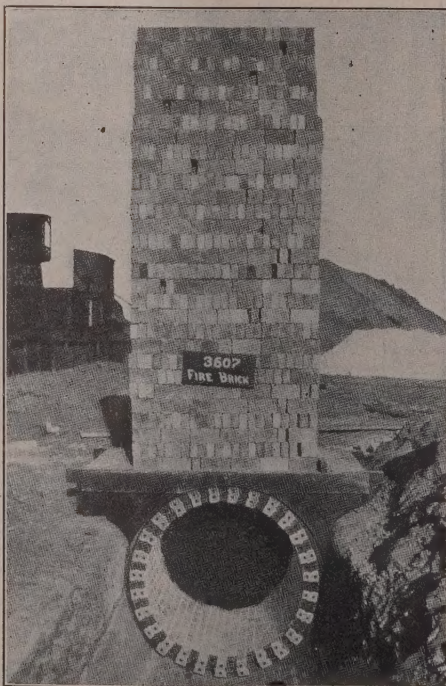
New Radial Interlocking Brick Lessens Cost of Sewer Construction

A new radial interlocking brick which is claimed by the manufacturer to materially lessen the cost of sewer and conduit construction, as compared to ordinary brick, due to the lesser thickness of wall required, has recently been put on the market. It is made to fit the radius of the circle in sewers or conduits whatever the diameter may be. When the brick, upon being laid, are shoved up the mortar is forced into openings in the ends, forming rigid dowels and bonding the structure lengthwise. Radial interlocking is secured by projections and grooves, and the bonding is further strengthened by the tapered section. They are claimed to give a much stronger construction than ordinary brick. The saving is in the lesser quantity of material required with the consequent saving in hauling, handling and mortar required. These bricks, known as the Frost Radial Interlocking Brick, are manufactured by the Los Angeles Pressed Brick Company of Los Angeles, Cal.

Trade Publications

The following companies have recently issued trade literature:

Ayer & Lord Tie Company, Railway Ex-



RADIAL INTERLOCKING BRICK WITHSTAND GREAT PRESSURE IN THIS TEST

change Building, Chicago. Booklet, 6½ x 3½ in., 16 pages, illustrated. Interior wood block for plant floors.

Fairbanks Steam Shovel Company, Marion, Ohio. Folder, 9 x 12 in., 4 pages, illustrated. A brief description of the Fairbanks gasoline ⅝-cu. yd. standard and revolving traction shovels.

Stow Manufacturing Company, Binghamton, N. Y. General catalog 14, 6 x 9 in., 96 pages, illustrated. Covers flexible shaft drilling, grinding and buffing machinery and their appurtenances.

Zeiser Brothers, Berwick, Pa. Catalog, 5 x 7¼ in., 24 pages, illustrated. All steel sidewalk forms and curb and gutter forms for concrete construction. Features in manufacture and application are described.

Knickerbocker Company, Jackson, Mich. Catalog, 6 x 9 in., 40 pages, illustrated. Knickerbocker batch concrete mixers, in 6-ft. and 10-ft. sizes, and Coltrin continuous types. The descriptions are general, the detailed facts being confined to specifications.

W. J. Stevenson, 1720 Cedar Street, Milwaukee, Wis. Catalog, 8 x 11½ in., 12 pages, illustrated. Contains comments and testimonials on the achievements of the Stevenson improved sewer cleaning machine, and illustrates it in action with some of the results.

Mead-Morrison Manufacturing Company, East Boston, Mass. Pamphlets 103, 104 and 105, 6 x 9 in., 4 pages each, illustrated. This company's latest type of electric grab bucket, its contractors' derrick swinging engine and hoist, and independent electric motor drive for hoist.

Barber Asphalt Paving Company, Iroquois Works, Buffalo, N. Y. Booklet, 9 x 6 in., 16 pages, illustrated. Contains a number of excellently reproduced pictures of roads on large estates, parks and country clubs. The text discusses the advantages of the roadways illustrated.

Asbestos Protected Metal Company, Pittsburgh. Booklet, 3½ x 6¼ in., 12 pages, illustrated. Embodies general points on the construction and use of Pittsburgh paving joint, an asphalt compound reinforced with linen mesh which, it is claimed, prevents stretching or distortion.

Otis Elevator Company, Eleventh Avenue and Twenty-sixth Street, New York. Booklet, 6 x 9 in., 32 pages, illustrated. An artistic presentation of an article on the emergency dams and girder and hoisting machines at the Panama Canal, manufactured and installed by this company.

Mesta Machine Company, Pittsburgh. Bulletin Ka, 6 x 9 in., 4 pages, illustrated. Reproduces a horsepower chart for determining the variables for gears, pulleys, rope wheels and other rotating parts transmitting power. A blueprint sixteen times the size of this reproduction may be obtained on application.

Jenkins Brothers, 80 White Street, New York. Catalog 20, 4 x 6¼ in., 256 pages, cloth-bound, illustrated. A complete catalog and price list of this firm's line of valves, packing and mechanical rubber goods. It embraces renewable disc, extra heavy brass and iron, radiator, gate, heavy cast-steel valves, flanges and drilling, gages, mason regulating devices and mechanical rubber goods. Price list of parts, tables of dimensions, telegraph code and a general index are appended to complete the publication.

Du Pont Powder Company, Wilmington, Del. Bulletin. A comprehensive treatise, covering the location, building and maintenance of roads. It discusses civic and economic progress relative to roads, gives detailed advice on right-of-way, grubbing, drainage, road building equipment and different kinds of roads and instructs the reader in regard to the uses of explosives and their handling. Obviously the publication promotes the rational use of explosives, yet its text is much broader in scope and covers phases of road construction distinctly far apart from just that.